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American Physicians and Surgeons.

FIRST TRIENNIAL SESSION,

HELD AT

WASHINGTON, D. C.

September 18th, 19th and 20th, 1888.

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OF

1888.

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HISTORICAL INTRODUCTION.

At the Seventh Annual Meeting of the AMERICAN SURGICAL ASSOCIATION held in Washington, D. C., April 28, 29, 30, and May 1, 1886, Dr. CLAUDIUS H. MASTIN, of Mobile, Ala., read the following communication:

TO THE FELLOWS OF THE AMERICAN SURGICAL ASSOCIATION:

GENTLEMEN—In view of the fact that there are a number of Special Medical Organizations now in existence in the United States, each having for its aim and attainment, the advancement of the special department of medicine for which it was organized; and since the members of said special societies are of the representative men of the profession in America, many of whom are, at the same time, fellows or members of several of these special societies, which double membership, if I may so express it, necessitates them, if desirous of attending two or more of the meetings of these societies the same year, to make as many separate trips from home, and often with much loss of time to themselves and inconvenience to their patients; therefore it appears necessary that some arrangement should be made with the different societies as to a uniform time and place of holding their sessions, so that those members who wish to attend the meetings of more than one association may be enabled to do so without useless expenditure of money, or unnecessary loss of time.

An extended correspondence, together with personal conference with many of the most prominent of the fellows of this and other associations has disclosed the fact that there is a decided and growing inclination on their part to unite the various societies into a common whole, whereby it would become an organization representative of the various special departments of the profession in America.

The plan proposed, which I now offer for the consideration, and I hope approval, of the Fellows of the Surgical Association, is to unite the following named associations into a Congress based upon the outlines which are now to be explained:

1. American Surgical Association.
2. American Ophthalmological Association.
3. American Otological Association.
4. American Neurological Association.
5. American Laryngological Association.
6. American Gynæcological Association.
7. American Dermatological Association.
8. American Climatological Association.
9. American Clinical and Pathological Association.

These Associations to be united under the name and style of "THE CONGRESS OF AMERICAN PHYSCIANS AND SURGEONS."

The plan of organization hereby submitted, and subject to any alterations or amendments which this association may deem wise and proper, is that each society shall preserve its own name, constitution, and by-laws; elect its own officers and Fellows; hold its own sessions apart from the others at the time and place of meeting; publish its own transactions, and do all other acts of which, by virtue of its constitution and by-laws, it has the inherent right to do, thus preserving its own autonomy.

The Congress to be composed of these Special Societies when in convention, and its meetings to be held annually in the city of Washington, the most appropriate place for the assembling of a *National Organization.* The constitution and by-laws of the Congress to be formed by a committee composed of a like number chosen from each separate society. The opening session of each annual meeting of the Congress to be devoted to such general business as may pertain to the interest of the associations as a whole. The Congress to be presided over by a President, elected annually, and who must deliver the opening address upon the first day of the session. The manner of choosing a President to be as follows: by a nominating committee composed of one fellow or member elected from each special association, or otherwise, as may be determined upon by the special society itself; this committee nominating one or more candidates for the office of President, whose election is to be by ballot on the last day of the annual session, and in a convention of all the societies assembled. The Presidents of the special societies to become *ex-officio* Vice-Presidents of the Congress. Membership in the Congress to be acquired only by virtue of fellowship in one or another of the special associations. Other officers of the Congress to be elected or appointed as may hereafter be determined upon by the associations in convention.

These are the outlines of a Union, proposed for the consideration of the Fellows of this Association, which, if it should meet their approval, can be submitted to the action of the societies which have herein been mentioned. I would suggest, in the event of favorable reception by this Association, that a committee of five be appointed by the chair, which committee shall bring the subject before the next special association which meets this spring or coming summer, and which, in the event of a concurrence of opinion on the part of said society, shall act in concord with their committee appointed to confer with the other societies, in the order of their meetings—this enlarged committee to report at a convention of all the societies, who shall be requested to hold their next annual meetings at the same dates in the month of June, 1887, in the city of Washington.

To avoid any confusion as to the time of the next meeting, each society (this year) could adjourn to meet in June, 1887, leaving the date to be fixed by the enlarged committee after their work of conference had been finished, it then being only necessary to apprise the secretaries of the respective Associations, who will give notice to their various Fellows or members.

These are the crude outlines of a plan for uniting the special societies of the country into a National organization, which I now submit for the action of this Association.

The subject may be unexpected to some of you, and may not meet your entire approval. Still, it is the result of calm consideration, and has been approvingly endorsed by quite a number of the representative gentlemen of the profession, both in and out of this special association.

We disclaim any intention of offering any obstacle or opposition to any other Association in America. We propose, simply, a plan of uniting into one great body, the already existing special societies, and we do so from the honest conviction that such a union will prove of inestimable benefit to them, individually and collectively.

I trust the scheme may meet your approval, and if so, that such steps as your wisdom may suggest be taken to further its accomplishment.

I have the honor to be, with much respect,

C. H. MASTIN.

Washington, D. C., April 28th, 1886.

The communication was after discussion referred to a Committee, which on the following day reported * * * *

That the Committee views with great satisfaction the perfection of a plan through which the meeting of the Associations above named, in the City of Washington, at the same time of the year, may be accomplished, and the meetings of all of these Associations in general assembly on such days as may be determined, for the purpose of the delivery of addresses upon general subjects in medicine—such meetings to be held without any formal organization, through which the Associations meeting will sacrifice their autonomy. To accomplish these purposes, the Committee respectfully offers the following resolution :

"*Resolved*, That a Committee of five Fellows of this Association be appointed, which shall be authorized to confer with Committees of the other Associations interested, in the adoption of a plan of a Convention as hereinbefore stated, and report upon the same, at the next meeting, for the action of the Association.

J. EWING MEARS, *Chairman*,
CHRISTOPHER JOHNSTON,
W. T. BRIGGS."

The resolution contained in the report was adopted, and Drs. C. H. Mastin, Chas. T. Parkes, J. Ford Thompson, J. Ewing Mears, N. Senn, were appointed the Committee.

The Committee forwarded the communication of Dr. Mastin and the report of the Committee to the various Associations mentioned, and each appointed a Committee of Conference of five, as requested.

In response to a notification from the Secretary of the Committee of the American Surgical Association, these Committees met for conference at the Army Medical Museum in Washington, D. C., September 24th, 1886.

The Convention was called to order by Dr. C. H. Mastin, of the Surgical Association, and organized by the election of Dr. Samuel C. Busey, of the Gynæcological Society, Chairman, and Dr. J. Ewing Mears, of the Surgical Association, Secretary.

The Secretary then reported that he had received official notification of the following Committees having been appointed by the several special Associations, which had been invited to join in the formation of "A Congress of American Physicians and Surgeons:"

1st. American Ophthalmological Association.
O. F. Wadsworth, M. D., Boston.
C. S. Bull, M. D., New York.
G. C. Harlan, M. D., Philadelphia.
Samuel Theobold, M. D., Baltimore.
R. E. Freyer, M. D., Kansas City.

2d. American Otological Association.
C. R. Agnew, M. D., New York.
Herman Knapp, M. D., New York.
John Green, M. D., St. Louis.
W. H. Carmalt, M. D., New Haven.
George Strawbridge, M. D., Philadelphia.

3d. American Gynæcological Association.
Samuel C. Busey, M. D., Washington.
Fordyce Barker, M. D., New York.
J. R. Chadwick, M. D., Boston.
J. Tabor Johnston, M. D., Washington.
Thomas A. Emmet, M. D., New York.

4th. American Laryngological Association.
J. Solis Cohen, M. D., Philadelphia.
F. I. Knight, M. D., Boston.
G. W. Lefferts, M. D., New York.
F. H. Bosworth, M. D., New York,
E. L. Shurley, M. D., Detroit.

5th. American Dermatological Association.
H. G. Piffard, M. D., New York.
F. B. Greenough, M. D., Boston.
R. B. Morrison, M. D., Baltimore.
L. N. Denslow, M. D., St. Paul.
G. H. Tilden, M. D., Boston.

6th. American Surgical Association.
C. H. Mastin, M. D., Mobile.
C. T. Parkes, M. D., Chicago.
N. Senn, M. D., Milwaukee.
J. Ford Thompson, M. D., Washington.
J. Ewing Mears, M. D., Philadelphia.

7th. American Neurological Association.
L. C. Gray, M. D., Brooklyn.
J. Van Bibber, M. D., Baltimore.
E. C. Seguin, M. D., New York.
Wharton Sinkler, M. D., Philadelphia.
Philip Zenner, M. D., Cincinnati.

8th. American Climatological Association.
  A. L. Loomis, M. D., New York.
  F. Donaldson, M. D., Baltimore.
  F. C. Shattuck, M. D., Boston.
  E. T. Bruen, M. D., Philadelphia.
  W. W. Johnston, M. D., Washington.
9th. Association of American Physicians and Pathologists.
  Wm. Pepper, M. D., Philadelphia.
  Francis Delafield, M. D., New York.
  R. T. Edes, M. D., Boston.
  J. Palmer Howard, M. D., Montreal.
  J. T. Whittaker, M. D., Cincinnati.

The following were present :

1st. The Ophthalmological.
  O. F. Wadsworth, M. D.
  Samuel Theobold, M. D.
2d. The Otological.
  C. R. Agnew, M. D.
  W. H. Carmalt, M. D.
  Wm. Thomson, M. D., (in place of Dr. Strawbridge).
3d. The Gynæcological.
  S. C. Busey, M. D.
  J. R. Chadwick, M. D.
  J. Tabor Johnston, M. D.
4th. The Laryngological.
  F. I. Knight, M. D.
  E. L. Shurley, M. D.
5th. The Dermatological.
  H. G. Piffard, M. D.
  G. H. Tilden, M. D.
6th. The Surgical.
  C. H. Mastin, M. D.
  J. Ford Thompson, M. D.
  J. Ewing Mears, M. D.
7th. The Neurological.
  L. C. Gray, M. D.
  J. Van Bibber, M. D.
  W. Hendrie Lloyd, M. D., (in place of Dr. Sinkler).
8th. The Climatological.
  F. Donaldson, M. D.
  W. W. Johnston, M. D.
9th. Association of Physicians.
  Wm. Pepper, M. D.

Dr. William Pepper, of Philadelphia, then offered the following resolutions, which, after careful consideration and discussion were adopted separately, and then as a whole :

RESOLUTIONS.

Resolved, First, That it is desirable that the following Societies :

The American Surgical Association,
The American Ophthalmological Association,
The American Otological Association,
The American Neurological Association,
The American Laryngological Association,
The American Gynæcological Association,
The American Dermatological Association,
The American Climatological Association,
The Association of American Physicians and Pathologists,

shall arrange for a conjoint meeting in the City of Washington, in the month of September, 1888, and subsequently at intervals of three years, at the same time and place.

Second. That this arrangement shall not interfere in any way with the autonomy of each special Society, and that each Society shall retain the right to withdraw at any time from this conjoint scheme.

Third. That the special feature of the meeting shall be the conjoint assemblage of the special Societies on two evenings during the Session, on one of which there shall be an address delivered by the President of the conjoint meeting, and on the other there shall be communications by a referee and a co-referee, on some subject of general professional interest.

Fourth. That each special Society approving this Report is invited to appoint one representative (with an alternate), and that the representatives so appointed shall constitute an Executive Committee to serve for one year, with power to elect such officers for the first conjoint meeting as may be deemed necessary ; to prepare a programme for said meeting ; to make all other necessary arrangements, and to prepare and submit a plan of organization for future meetings.

Fifth. That all expenses connected with the conjoint session shall be apportioned equally by the Executive Committee among the special Societies participating.

These resolutions were reported to the several Societies by their respective Committees, and to the American Association of Genito-Urinary Surgeons, and Delegates, with Alternates, to form the Executive Committee were appointed as follows, viz :—

American Surgical Association.

DELEGATES.	ALTERNATES.
Dr. C. H. Mastin, of Mobile, Ala.	Dr. J. Ford Thompson, of Washington, D. C.

American Association of Genito-Urinary Surgeons.

Dr. Jno. P. Bryson, of St. Louis, Mo.	Dr. C. H. Mastin, of Mobile, Ala.

DELEGATES.	ALTERNATES.
American Laryngological Association.	
Dr. J. Solis Cohen, of Philadelphia.	Dr. F. J. Knight, of Boston, Mass.
American Climatological Association.	
Dr. Alfred L. Loomis, of New York City.	Dr. F. Donaldson, Sr., of Baltimore, Md.
Association of American Physicians.	
Dr. Wm. Pepper, of Philadelphia.	Dr. Reginald H. Fitz, of Boston, Mass.
American Otological Society.	
Dr. Cornelius R. Agnew, of New York City.	Dr. Wm. H. Carmalt, of New Haven, Conn.
American Ophthalmological Society.	
Dr. William F. Norris, of Philadelphia.	Dr. D. B. St. John Roosa, of New York City.
American Neurological Society.	
Dr. Landon C. Gray, of Brooklyn, N. Y.	Dr. Chas. K. Mills, of Philadelphia.
American Dermatological Association.	
Dr. I. E. Atkinson, of Baltimore, Md.	Dr. Geo. H. Tilden, of Boston, Mass.

and the first meeting of the Committee was held October 5th, 1887, in the Hall of the College of Physicians, in Philadelphia.

It organized by the election of Dr. William Pepper for Chairman, and Dr. Jno. P. Bryson, Secretary. There were present:

Delegate from the American Surgical Association:
Dr. C. H. Mastin, of Mobile.

Delegate from the American Laryngological Association:
Dr. J. Solis Cohen, of Philadelphia.

Delegate from the Association of American Physicians:
Dr. William Pepper, of Philadelphia.

Delegate from the American Neurological Association:
Dr. Landon Carter Gray, of Brooklyn.

Delegate (alternate) *from the American Ophthalmological Society:*
Dr. D. B. St. John Roosa, of New York.

Delegate from the American Otological Society:
Dr. Cornelius R. Agnew, of New York.

Delegate from the American Climatological Association:
Dr. Alfred L. Loomis, of New York.

Delegate from the Association of Genito-Urinary Surgeons:
Dr. Jno. P. Bryson, of St. Louis.

Delegate of American Dermatological Association:
Dr. I. E. Atkinson, of Baltimore :

and by invitation in common with the other alternates, but not voting, Dr. Chas. K. Mills, of Philadelphia, of the American Neurological Association, Dr. Wm. H. Carmalt, of New Haven, of the American Otological Society, and Dr. J. Ford Thompson, of Washington, of the American Surgical Association.

It was determined *inter alia :*

First :—That the conjoint meeting of the Associations be named "THE CONGRESS OF AMERICAN PHYSICIANS AND SURGEONS."

Second :—That the place of meeting be in Washington, D. C.

Third :—That the first meeting be on Tuesday, Wednesday, Thursday (and Friday), the 18th, 19th, 20th (and 21st) days of September, 1888, and that the subsequent meetings of the Congress be at intervals of three years.

Fourth :—That the meetings on Tuesday and Wednesday evenings be devoted to scientific papers and discussions, and that on Thursday evening the address of the President be read.

Fifth :—That the Congress be composed of the accredited members of the nine Societies represented on this Committee, and of such other societies as may be elected by a unanimous vote of the Executive Committee.

Sixth :—That there shall be a President and as many Vice-Presidents as there may be Associations in the Congress, and that the Presidents elect of the Associations for that year shall be *ex-officio* Vice-Presidents of the Congress.

Seventh :—That the President and Secretary of the Congress shall be *ex-officio* members of the Executive Committee.

Eighth :—That on the first day of the Congress, Tuesday, September 18th, a short business meeting for organization be held to receive the REPORT of the EXECUTIVE COMMITTEE, and that a draft of proposed BY-LAWS be submitted.

Ninth :—That the preparation of the programme for the first session of the Congress be referred, with power, to a Committee consisting of the President of the Congress, the Chairman of the Executive Committee, and the Secretary of the Congress.

Tenth :—Dr. John Shaw Billings, of Washington, D. C., U. S. A., was elected President ; Dr. Wm. H. Carmalt, of New Haven, Connecticut, was elected Secretary, and Dr. D. B. St. John Roosa, of New York City, was elected Treasurer of the Congress.

The President appointed the following

COMMITTEE OF ARRANGEMENTS :

From the ASSOCIATION OF AMERICAN PHYSICIANS.
Dr. Samuel C. Busey, Chairman, Washington, D. C.

From the AMERICAN SURGICAL ASSOCIATION.
Dr. J. Ford Thompson, Washington, D. C.

From the AMERICAN ASSOCIATION OF GENITO-URINARY SURGEONS.
Dr. A. T. CABOT, Boston, Mass.

From the AMERICAN LARYNGOLOGICAL ASSOCIATION.
Dr. E. C. Morgan, Washington, D. C.

From the AMERICAN CLIMATOLOGICAL ASSOCIATION.
Dr. W. W. Johnston, Washington, D. C.

From the AMERICAN OTOLOGICAL SOCIETY.
Dr. S. O. Richey, Washington, D. C.

From the AMERICAN OPHTHALMOLOGICAL SOCIETY.
Dr. Samuel Theobald, Baltimore, Md.

From the AMERICAN NEUROLOGICAL ASSOCIATION.
Dr. Robert T. Edes, Washington, D. C.

From the AMERICAN DERMATOLOGICAL ASSOCIATION.
Dr. I. E. Atkinson, Baltimore, Md.

From the AMERICAN PHYSIOLOGICAL SOCIETY.
Dr. H. Newell Martin, Baltimore, Md.

From the AMERICAN ORTHOPEDIC ASSOCIATION.
Dr. A. Sidney Roberts, Philadelphia, Pa.

The Committee on the preparation of a programme for the first session of the Congress selected for Tuesday evening, September 18th, the subject of

INTESTINAL OBSTRUCTION IN ITS MEDICAL AND SURGICAL RELATIONS,

and appointed DR. REGINALD H. FITZ, of Boston, Mass., Professor of Pathological Anatomy in Harvard University, and

DR. NICHOLAS SENN, of Milwaukee, Wisconsin, Professor of Surgery in the Rush Medical College, of Chicago, Illinois, to read papers, and

Drs. William Pepper, of Philadelphia, William H. Draper, of New York, J. Collins Warren, of Boston, Thomas G. Morton, of Philadelphia, to discuss the subject.

For Wednesday evening, September 19th, the subject of

CEREBRAL LOCALIZATION IN ITS PRACTICAL RELATIONS

was selected, and

DR. CHARLES K. MILLS, of Philadelphia, Professor of Diseases of the Mind and Nervous System in the Philadelphia Polyclinic and College of Graduates in Medicine, and

DR. ROSWELL PARK, Professor of Surgery in the Buffalo Medical College, were appointed to read papers, and

Mr. Victor A. H. Horsley, F. R. C. S., Drs. David Ferrier, M. Allen Starr, W. W. Keen, E. C. Seguin, and Robert F. Weir to discuss the subject.

THE PRESIDENT announced

MEDICAL MUSEUMS

to be the subject of his Address for Thursday evening, September 20th.

The American Physiological Society was admitted to the Congress on January 23rd, 1888, and appointed Dr. H. P. Bowditch, of Boston, Delegate, and Dr. H. Newall Martin, of Baltimore, Alternate on the Executive Committee.

The American Orthopedic Association was admitted on February 21st, 1888, and appointed Dr. Newton M. Shaffer, of New York, Delegate, and Dr. L. Hall Sayre, of New York, Alternate.

On September 18th, 1888, previous to the meeting for organization of the Congress, the American Gynæcological Society, one of the Societies originally invited to participate in the Congress, and which sent a committee to the meeting of Conference of September 24th, 1886, forwarded to the EXECUTIVE COMMITTEE the names of Dr Fordyce Barker, of New York, as Delegate, and Dr. Wm. Goodell, of Philadelphia, as Alternate.

MINUTES.

The first meeting of the Congress was called to order Tuesday, September 18th, 1888, in the Main Hall of the Grand Army Building, Pennsylvania Avenue, Washington, D. C., at 1 P. M., by DR. WILLIAM PEPPER of Philadelphia, CHAIRMAN of the EXECUTIVE COMMITTEE, who spoke as follows:

I would remind you that this Congress is formed by the joint and simultaneous meeting of the following societies: the American Surgical Association, the American Association of Genito-Urinary Surgeons, The American Laryngological Association, the American Climatological Association, the Association of American Physicians, The American Otological Society, The American Ophthalmological Society, The American Neurological Association, the American Dermatological Association, the American Physiological Society, the American Orthopedic Association, and the American Gynecological Society. The committee of which I have the honor to be chairman is composed of representatives from the above named Societies, as follows: Drs. Claudius H. Mastin, of Mobile, Ala.; John P. Bryson, of St. Louis, Mo.; J. Solis Cohen, of Philadelphia; Alfred L. Loomis, of New York; William Pepper, of Philadelphia; William H. Carmalt, of New Haven, Conn.; William F. Norris, of Philadelphia; Landon Carter Gray, of New York; I. E. Atkinson, of Baltimore; Henry P. Bowditch, of Boston; Newton M. Shaffer, of New York; and Fordyce Barker, of New York.

On behalf of this Executive Committee I have the honor to announce to you, the members of the various special associations comprising the CONGRESS OF AMERICAN PHYSICIANS AND SURGEONS, the manner in which we have discharged the responsible duty entrusted to us. The present meeting is the result of prolonged deliberations. The development of one special society after another showed the irresistible tendency of the recent progress of medical science. The deep interest which attaches to the meetings of these separate bodies suggested naturally the thought of a conjoint meeting which would bring together the active workers in allied fields. This thought did not, however, take any definite shape until at the annual meeting of the American Surgical Association in April, 1886, Dr. Claudius H. Mastin, of Mobile, Alabama, presented a memoir* in which are stated with admirable clearness the details of the plan which was subsequently adopted and carried into effect. The measures recommended in this important communication were approved by the Surgical Association; and it is therefore to it, and especially to our distinguished colleague Dr. Mastin, that must be awarded the honor of having initiated a movement which is destined to exert a powerful influence upon American Medical Science. Nor should I fail to bear testimony here to the unwearying and unselfish zeal with which from that day to the present Dr. Mastin labored to insure the completion of this great enterprise, which owes its inception and much of its success directly to him. At the time above mentioned, the attention of the medical profession was occupied with the preparation for the meeting of the International Medical Congress which occurred in this city last year; and consequently all action on the part of the Special Associations was deferred in order that there should not be even a semblance of interference with that important meeting. The delay has not been injurious. It has rendered more conspicuous than ever the actual need of an organization to secure the reunion at stated intervals of the more active teachers and writers and workers in the leading branches of medical science. These reunions must be held in a city to which it will be possible to draw such men from all quarters. In order to produce the best scientific results it is essential that the numbers in attendance shall be reasonably limited, and that as far as possible the same men shall attend successive meetings. A continuity of intellectual life and activity is thus secured which increases greatly the benefits to be derived from these meetings. A large number of those interested in the development of such an organization are, like myself, warmly attached to the American Medical Association and are determined to exert their influence to maintain and promote the success of this great national organization. All of us are no less warmly interested in the prosperity of the various special societies to which we severally belong. Your Executive Committee found little difficulty, however, in deciding upon a plan which would prevent even the least interference with the American Medical Association, while at the same time any encroachment upon the independence and autonomy of the special societies was avoided. It is unnecessary to dwell upon the special points which have been embodied in the

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* See page xiii.

BY-LAWS which will be immediately submitted to you. Your committee ventures to hope that these provisions, which are strictly in accord with the terms of the resolutions under which it was appointed, will meet the unanimous approval of the Congress.

We have recommended that the sessions shall be triennial—thus leaving to each participating body two intervening independent meetings at such time and place as may be chosen. We have jealously guarded against the admission of the least parliamentary business into the work of the Congress, the functions of which are designed to be absolutely and exclusively scientific. Thus and thus only can the sessions of this body be lifted up into and maintained in that high and calm air of learned discourse which best permits the diffusion of truth and the promotion of science. We have no less jealously guarded the independent sovereignty of each participating society. To all their full rights are preserved ; to all equal privileges are accorded ; upon all the burden of expense which should always be but a light one, has been laid in equitable distribution.

The successive meetings of the Congress will be held in this beautiful city which each year renders more accessible, more attractive, and more precious to every citizen of the Republic. Nor could we fail to make acknowledgment of the great material advantages we shall enjoy in these meetings here, through the liberal and enlightened policy which places freely at our disposal the admirable facilities of the medical department.

Here too, your Executive Committee would gladly acknowledge we have found colleagues in the members of the committee of arrangements to whom, and especially to whose chairman, Dr. S. C. Busey, we desire to return cordial thanks for a zealous and harmonious cooperation which has contributed in very large measure to the successful inauguration of this new organization.

And lastly your Executive Committee would report that in the discharge of one of their most important duties we have reached the conclusion that the selection of the presidents of each Congress shall be entrusted to the Executive Committee then in office. Then will the choice of the most worthy and best representative men of the whole country be insured at the hands of a truly representative body specially selected by their various societies for their ability and judgment. The powers you are asked to confide to future executive committees are large, but they will be reposed in safe hands. Each society participating will be stimulated to continuous and lofty endeavors. Membership in any of these bodies will come to be regarded as more and more an honor ; and in time the scientific qualifications of candidates will be more and more strictly scrutinized.

It may seem scarcely proper to express on this occasion a grave apprehension which close study of the conditions of this Congress has impressed upon your committee. It will, we think, be universally conceded that if this organization were to have the effect of favoring the extreme multiplication and subdivision of special societies it would be nothing less than a calamity. The combination and coöperation of the recognized leading specialties is a conservative influence. But the encouragement of a needless increase of societies devoted to minute fragments of medical science would have a disintegrating and injurious result. We have therefore provided that the admission of new associations shall be secured only by the unanimous vote of the Executive Committee.

But it is evident that if the limited number of special associations which participate in this first Congress is to be guarded by so strict though wholesome a rule as this, there is surely imposed upon each of these bodies a weighty responsibility as to the condition they shall exact from their members and from candidates for admission to membership. Your committee feel convinced that the value, nay, the very existence of this Congress, must depend wholly and solely upon the scientific activity of the members, and upon the exaction from every candidate of the strongest evidence of similar activity, present and prospective. It is not the number in attendance at such a meeting as this ; it is not the social enjoyment which we all desire from these reunions which will determine the value and success of the Congress. The sole justification of this especial organization must be sought in the solid value of the work here done, and in the stimulation it will afford to genuine scientific activity within the ranks of the societies participating, in those bodies which aspire to union with the Congress, and on the part of individual candidates for membership in any of our special societies.

But on the other hand can there be any doubt that if the unselfish and earnest spirit which has led to the formation of this Congress be maintained and cherished, that it will exert a powerful and beneficent influence on the future of medical science, and that a long and illustrious future is reserved for this organization.

It remains only to add that in exerting the privilege of selecting a president for this first CONGRESS OF AMERICAN PHYSICIANS AND SURGEONS your Executive Committee feel we have been guided to the choice of a man whose admirable personal character, whose high attainments, and whose illustrious services in the cause of literature, of science, and of the entire medical profession, mark him as entitled to this great honor and distinction.

It gives us therefore the utmost gratification to present to you our president, Dr. John Shaw Billings, and to announce that the CONGRESS OF AMERICAN PHYSICIANS AND SURGEONS is now duly organized.

Dr. Billings spoke as follows :—

Gentlemen of the Congress :

In behalf of the Medical Departments of the Government, and especially of the Medical Department of the Army, I beg to return thanks for the high honor which you have conferred upon them in selecting one of their representatives as the President of this Congress. I can not refrain from also adding the assurance of my heartfelt appreciation of the personal good-will and friendship which must have had something to do with the selection of myself as that particular representative and which is evidenced in the manner in which the selection has been received by you. I do not think that at the present time I can show this appreciation better than by getting my own personality out of the way as soon as possible. We shall therefore at once proceed with the programme indicated by the Chairman of the Executive Committee.

Before doing this I wish to read a telegram handed to me as I came into the hall. It is from Sir Henry Acland, late President of the General Medical Council of Great Britain, and reads as follows : "Success to all medicine and biology in the United States."

Dr. Samuel C. Busey of Washington, Chairman of the Committee of Arrangements, was then introduced and delivered the following address of welcome to the Congress.

Mr. President and Gentlemen :

In behalf of the Committee of Arrangements, and of the profession and citizens of this city, I bid you welcome.

The circumstance of the simultaneous assemblage here to-day of the special medical societies of this country will mark an epoch in the history of the American Medical Profession which must redound to its honor and renown. In the fact that it brings together at the same time and place those bodies of men which hold in their membership so many who have devoted their lives and energies to the study and development of special branches of medical science, and have won by their work preëminence as skilled physicians and surgeons, in an organization that offers the unusual opportunity, by systematic arrangement, for the consideration, by specialists equally distinguished in different branches, of subjects, as yet unsettled but of general medical interest, it is, perhaps, the most remarkable concourse of medical men that has ever assembled in this country. While it sets forth conspicuously this distinctive feature it in no manner interferes with the autonomy of the constituent societies, each of which pursues its chosen method according to its own plan of organization.

It utters no word in derogation of organized effort through allied associations ; nor does it directly or by implication seek to control, direct or influence the business aspects of the profession ; but devotes thought and act solely and exclusively to the advancement of the science of medicine. With such a purpose in view no apology is needed for your presence here.

The gratification it gives me to welcome you is enhanced by the presence of the distinguished men from other countries, who have come to honor and encourage us, and to make "assurance doubly sure" that the promise to contribute something to the common fund of knowledge will be fulfilled.

I welcome you also as a citizen of the city located by Washington and planned by L'Enfant, under his supervision, which has grown during the first century of its existence into a city surpassing in beauty and rivalling in attractiveness the more favored and older cities of both the old and new world. A city representing in its population sixty millions of free people inhabiting a domain stretching across a continent from ocean to ocean and from the frigid north, where the summer solstice finds the earth buried in snow and ice, to the evergreen and tropical south. A city holding together in one compact community a cosmopolitan population where education and culture need neither the blazonry of titular insignia, the heraldry of ancestral distinction, nor the glamour of wealth to command position and influence. Where the lady and the gentleman can always find congenial and cultivated companionship free from the conventional and exclusive formalities which disrupt society into graded coteries of self-constituted notables. Where you will not be surprised to find a place of residence that has attracted the cultivated and leisure classes from every state and city in the Union.

I welcome you also as a citizen of a city richly endowed by a munificent government with scientific foundations, not as yet complete in any department, but steadily progressing towards that standard of excellence and usefulness which will, in the near future, make the political home of the nation the center of its science, literature and art.

I need hardly tell you, gentlemen, how much this government has done for our profession. You know of the Medical Library, unequaled in volumes and value, and the Medical Museum, with its anatomical and biological laboratories, unsurpassed by any similar collection in the world, both now located in a building constructed for the purpose, and so arranged as to exhibit their extent to casual inspection, and to enhance their value for appropriate and available purposes.

In connection with this magnificent library the publication of the Index Catalogue, which enables the investigator to study any medical subject from its beginning down to its latest publication, and of which it is not too much to say, that it will contribute more towards the higher education of the profession than any single act of any nation on the face of the globe. And all this has been accomplished in the lifetime of one man, who still lives to prosecute his labors with that diligence, fidelity and pertinacity which marks the unselfish and conscientious enthusiast.

Then, too, the government has established, in connection with the Bureau of Naval Medicine and Surgery, a Museum of Hygiene, which offers to every citizen the opportunity to examine and study the relative advantages and utility of every device and appliance for the improvement and perfection of the hygiene of the dwelling. Under the fostering care of a liberal government and the conscientious discipline of the Naval Bureau of Medicine this establishment has already become an important adjunct to preventive medicine, and will, without doubt, continue to grow in usefulness both to the government and to the country at large.

The National Quarantine and Marine Hospital Service is another establishment which allies the government with the medical profession and brings it close to the people of the country in its beneficent purpose to provide for the sick and disabled sailors of the Merchant and Revenue Marine, and to prevent the introduction and spread of contagious diseases into the country through its maritime ports.

It may be that the government required these establishments to fulfill its delegated functions, and is compelled to secure the services of skilled medical men to superintendent their proper administration; nevertheless, even admitting this necessity to be the primary cause for their creation, it in no manner impairs their value to the profession, and their foundation imposes upon us the duty to utilize them for the common good, and invite us to aid to develop and widen the scope of these endowments to the end that we and the people may realize the full measure of their usefulness.

The bureaux of Army and Navy Surgery are also located here. It is true, they are corps, constituting an important and essential part of the complete equipment of the military establishment of the Nation. They are, nevertheless, the instrumentalities through which the government has been enabled to call into its service medical men of the highest order of professional attainments, and to accomplish so much in promoting the advancement of scientific medicine.

The government has been equally generous towards other departments of science. If the time and occasion permitted it would give me great pleasure to lay before you, in detail, the work being done in the scientific bureaux, established and supported by the general government in this city; and, also, to refer to the eleemosynary and educational institutions founded and exclusively supported by the government, as well as others to which it contributes annually a liberal though partial support. I must, however, be content with the bare statement of the fact that you may carry home with you the conviction which I wish to impress upon you, in behalf of our city, that by virtue of the foundations and endowments of the government, it has become a scientific and educational center equal to any and surpassing most of the older, richer and more populous cities of the country. In this connection I cannot omit reference to her admirable system of common schools, and her Universities: That of Georgetown, with its department of Humanities, Philosophy and Science, and of Law and Medicine; the Columbian, with its preparatory, scientific, law and medical departments; the National, limited, as yet, to Law, Medicine, and Dentistry; the Howard, specially devoted to the education of the colored citizens, with departments of Literature, Law, Medicine, Dentistry and Theology; and, finally, the new Catholic, now in course of organization and construction.

To all this let me add the Smithsonian Institution with its annexes of the National Museum and the Fish Commission; the Department of Education; the National Academy of Sciences, which, by law, is required to hold its annual sessions in this city; and the voluntary scientific organizations, known as the Philosophical, Biological and Anthropological societies, which bring together at stated periods the men of learning and science residing here either officially or for convenience or comfort, and you will realize something of the scope and importance of the scientific and educational work now carried on in this city as well as the prominent position already achieved by science, and the justification for our faith in the greatness of its future.

And now having briefly suggested our present and prospective claims to a prominent place as a scientific center, will you not join with me in the hope that this, the cosmopolitan city of the Nation, the heart of its political life, may also speedily become its scientific and educational Mecca, as well.

There is still another relation which the government holds to its Capital, the wisdom of which one cannot fully appreciate without a residence long enough to observe its practical bearing. By a provision of the Constitution the territorial area is held under the exclusive jurisdiction of Congress. The government holds in fee simple the title to all the public highways, the public buildings and the numerous parks; makes all laws, appoints all officers, levies, collects and disburses all taxes; and contributes an equal amount to the support of the municipality. To her the citizens are indebted for these beautiful streets, these avenues of shade trees, the flowing fountains and decorated parks which adorn the landscape at every turn with foliage, flowers and sward, and contribute so much to the healthfulness of the city.

This is the Capital of a great, growing and prosperous nation, beautiful in design and susceptible of greater and more magnificent embellishment. Every citizen of the country should share in the wish for its substantial improvement and adornment, that it may become commensurate with its importance and capabilities. The time is not very remote when the fostering care of a generous government and the energy of its resident population will make it the most desirable city for residence in this great and populous country. When its suburban elevations will be covered with winter residences and summer villas rivalling in beauty and grandeur the taste and display along the cliff at Newport.

I need hardly tell you that Washington is a healthy city; but I will send a message through each of you to the people at your homes, that you may tell them how much their government is doing to improve the healthfulness of this city. In times past we have read the graphic descriptions of the dreadful malaria that was so dense it could be sliced into blocks, followed people in fierce pursuit at every turn during the day, howled under the eaves at night, stole through the stomach, and sneaked under the nether garments. But, thanks to the government, the river marshes are being reclaimed, and, in the near future, the river front of our city will be covered by a magnificent park, washed along its entire shore by the swift current of a river of drinking water. You may tell them too, if you please, that the malaria of the correspondent and casual visitor covers some one or more of a great variety of excesses which prudent people should not commit. Take home with you this message, from one who has lived forty years in sight of, and breathed the air coming with every southern wind over, the Potomac flats, and has never yet had the fever and ague.

The BY-LAWS of the Congress as prepared by the EXECUTIVE COMMITTEE were then read by the Chairman as follows:

1.

This organization shall be known as the
CONGRESS OF AMERICAN PHYSICIANS AND SURGEONS.

2.

It shall be composed of national associations for the promotion of medical and allied sciences.

3.

It shall hold its sessions triennially in the city of Washington, D. C.

4.

The officers of the Congress shall be a PRESIDENT, VICE-PRESIDENTS, A SECRETARY, A TREASURER, AND AN EXECUTIVE COMMITTEE.

5.

The PRESIDENT shall be elected by the Executive Committee, of which he shall be *ex-officio* a member. He shall preside at the sessions of the Congress. He shall deliver an address.

6.

The PRESIDENTS of the participating societies shall be *ex-officio* the VICE-PRESIDENTS of the Congress.

7.

The SECRETARY and the TREASURER shall be elected by the Executive Committee. They shall be *ex-officio* members of the Executive Committee.

8.

The EXECUTIVE COMMITTEE shall be composed of one (1) member from each participating Society, and said members shall be elected by the various Societies at the next annual meeting subsequent to the Congress.

It shall be charged with all duties pertaining to the organization of and preparation for the ensuing Congress, including the election of all officers and of a Committee of Arrangements.

It shall superintend the publication of the Transactions of the Congress.

9.

The expenses of the Congress shall be divided between the participating Societies in proportion to their membership.

10.

The admission of new associations to participate in the Congress shall be by unanimous vote of the EXECUTIVE COMMITTEE.

These were adopted singly and as a whole.

The meeting for organization then adjourned.

The second meeting of the Congress was held in the Main Hall of the Grand Army Building, Tuesday evening, September 18th, at 8 o'clock. It was called to order by the President, who introduced Dr. R. H. Fitz, who read a paper, as appointed, on the DIAGNOSIS AND MEDICAL RELATIONS OF INTESTINAL OBSTRUCTION. He was followed by Dr. N. Senn on its Surgical Relations. Drs. Wm. Pepper and J. Collins Warren were then called upon by the President but declined in favor of the foreign guests; accordingly Dr. Arthur E. Durham, Senior Surgeon at Guy's Hospital, London; Dr. William M. Ord of St. Thomas' Hospital, London, and Professor Thomas Annandale of the Medical Department of the University of Edinboro', Scotland, were invited to speak by the President, after which Drs. Fitz and Senn closed the discussion.

The third meeting of the Congress was held in the same hall, Wednesday evening, September 19th. It was called to order at 8 o'clock, the President in the chair, who introduced Dr. Chas. K. Mills to read a paper on the DIAGNOSTIC FEATURES OF CEREBRAL LOCALIZATION. Dr. Roswell Park followed by a paper on its Surgical Relations. The discussion was opened by Dr. David Ferrier of London; he was followed by Mr. Victor A. H. Horsley, F.R.C.S., of London. Dr. M. Allen Starr then spoke on Aphasia. Dr. E. C. Seguin was called upon but declined in favor of the surgeons, whereupon Drs. W. W. Keen and Robert F. Weir spoke on some of its Surgical Aspects. Drs. Mills and Park closed the discussion.

The Congress held its fourth meeting on Thursday evening at 8 o'clock, in the Hall of the National Museum to listen to the address of the President on MEDICAL MUSEUMS, Dr. D. Hayes Agnew, the President of the American Surgical Association, *ex-officio* Vice-President, in the Chair.

After the address of the President, Dr. R. A. Kinloch, of Charleston, S. C., arose and addressed the Chair as follows:

"*Mr. Chairman:*

I feel a diffidence in appearing before so brilliant and appreciative an audience, but I think something is due to the members of this Congress who originated the idea of its organization and who have carried on so successfully, as illustrated in the past three days, the work for which it was instituted.

And first, all honor to my associate-fellow of the Surgical Association, Dr. C. H. Mastin, of Mobile, Ala., to whom belongs the conception of such an organization, and who has so assiduously worked for its full development. Now, the Congress has not only been created but it is already a healthy, vigorous body.

All honor to the Executive Committee, and to the officers who have so successfully presided over its deliberations, and to the local Committee of Arrangements whose foresight and admirable selections have facilitated our labor. By combined effort, and a happy coördination of many parts, we have as the result, a glorious whole.

And last, but not least, all honor to you, the noble co-workers of the special societies who surround me. It is you who, by your labor of three days past, have infused into this organization so permanent a life that it stands to-day before the American people, and before the world, a body ever to be remembered for the harmony of its action and the value of its scientific work.

It does not require the foresight of a prophet to predict that its young life-blood is destined to carry vitality and energy wherever the arteries of science and civilization shall extend.

May I indulge the hope that our successors for the ages to come will so maintain its character and enlarge its work that science will come to do it homage, and humanity rise up to call it blessed.

I move, Mr. President, that the thanks of this body be returned to Dr. Mastin, to the officers, and to the committee of arrangements, for the masterly manner in which they have discharged their duties."

The motion was unanimously carried.

Sir William MacCormac of London then addressed the Chair as follows:

"*Mr. Chairman:*

I have been asked to return thanks on behalf of the foreign guests, and were I able to do so adequately the task were a most pleasant one. But I feel that not I alone, but all of us together could scarcely do justice to your invariable kindness, exceeding courtesy, and overflowing hospitality. It makes us feel, indeed, that to you we are in no true sense foreigners. We are not only brother workers in the paths of science, but brothers by kindred and in speech as well as in other ways.

As many present will remember, I had a good deal to do with the organization of an International Medical Congress which met some time since in London, and it is, I suppose, because some of you recall that occasion, that I have now the honor to address you. If I may speak as one possessing some knowledge of the work a Medical Congress should do, I would wish most emphatically to record the opinion that this meeting has proved a most brilliant and successful one. The Congress to which I have just referred was an International one, but the meeting here in Washington is National, composed only of American physicians and surgeons, and therefore in most respects the two are scarcely comparable. This meeting is constituted by the men most representative, by their high scientific attainments and their good work, of the medical profession of this country. Many of them have come one thousand, two thousand, three thousand miles even, from North, South, East and West of this magnificent land in order to attend. Some ten or twelve of the special medical societies of America have agreed to meet together and my foreign colleagues and myself have been alike surprised by the number and value of the contributions to medical science in all its branches which this occasion has elicited. I took the pains to count them, and there are two hundred and fourteen essays altogether. In some sections the names of those taking part in the discussions are set down and among them I find sixty and more of the best known names from the various divisions of this great continent. I need not refer to the general discussions and addresses, which by common consent have delighted all those who have heard them. Being a surgeon, I devoted myself more especially to the Surgical Association, and can only regret I was unable to be more frequently present in some of the others. This, however, I can say with all sincerity that the contributions made in that Association, from the masterly and philosophical address of its President, Dr. Agnew onwards, were of the highest order of excellence, and as regards one of these contributions, I may even say, that I felt glad that for the privilege of hearing it alone I had crossed the Atlantic. It has been urged that these are societies of specialists and specialties. This objection is, I consider, largely met by the fact that these different societies assemble together at one and the same time, and also meet together in common general session of the Congress. The members must thus of necessity hold intercourse and interchange thought with each other.

You are, besides, most fortunate in being presided over at this, your first meeting, by a chief whose ability and position are alike unique and command the admiration of the scientific world. In the address by Dr. Billings, to which we have just listened, which I will not in his presence venture to characterize, he said some words which I took down at the time,—they are these: 'No single art or science should suffice for the sole object of a well balanced life.'

Gentlemen, such a man, not of one science, but of many, is your President.

We all thank you."

Dr. W. Pepper, of the Executive Committee, spoke as follows:

"The exercises of this evening bring to a close the first Congress of American Physicians and Surgeons. We have to congratulate ourselves on its complete success. The organization of the Congress was a task of some difficulty, and it had to be done under conditions which increased this difficulty. Yet the purpose intended was so definite, and the advantages to be derived were so obvious that a cordial understanding was soon effected on the part of all the Special Societies.

These organizations were already highly successful and useful. The anxiety felt by those who promoted their joint meeting in Congress at stated intervals, was that while each Congress should be notable and historic as marking the high-water lines of our medical work, the independent vigor and success of each separate society should be enhanced.

It is without hesitation I assert that so far as this first Congress is concerned, our anxiety has been dispelled. It will be admitted by all who have attended its session, and by all who shall read its record, that a higher level in scientific value has been reached than at any previous medical meeting in this country.

Organized for strictly scientific objects, so as to exclude rigidly all medical politics, all schemes of personal ambition, and all possibility of antagonism or interference with existing associations, it has proved capable of drawing not only the best men in American medicine, but of securing—what we have all felt to be one of the choicest advantages and pleasures of the occasion—the presence of many foreign colleagues of world-wide fame. Their cordiality and courtesy have added a charm to our social meetings while their words of weighty wisdom and of mature experience have won an increase of the high repute they already enjoyed among us.

But it yet remains to be demonstrated that the influence of this Congress upon individual societies is to prove all that has been hoped. Just so far as this hope is realized will the record of successive Congresses compare with that of the first.

We must consider that in perfecting this organization, we have set up for ourselves a lofty standard of professional and scientific duty. If it is to remain a high and coveted honor to be a member of the Congress of American Physicians and Surgeons, it will be because each special society guards its portals even more and more strictly; makes genuine ability and solid work the indispensable qualifications for admission ; and continued scientific activity the recognized duty of memberships. It is hoped, nay, it is believed with confidence, that these results will follow in every instance, so that, great as should be our satisfaction in reflecting upon the success already achieved, it must be far exceeded by that which we anticipate."

The Congress then adjourned *sine die.*

Wm. H. Carmalt,
Secretary.

The following gentlemen from other countries were present as
Invited Guests
of one or more of the different Associations.

Thomas Annandale, Esq., F.R.C.S.,	Edinburgh, Scotland.
Dr. A. B. Atherton,	Toronto, Canada.
Dr. James C. Cameron,	Montreal, Canada.
Arthur E. Durham, Esq., F.R.C.S.,	London, England.
Fred'k von Esmarch, Geh. Med.-Rath.,	Kiel, Germany.
Frederic S. Eve, M.D., F.R.C.P.	London, England.
David Ferrier, Esq., F.R.C.P.,	London, England.
Dr. William Gay,	London, England.
Reginald Harrison, Esq., F.R.C.S.,	Liverpool, England.
Robert Harvey, Surg. Maj. Bengal Army,	Liverpool, England.
Grailey Hewitt, Esq., F.R.C.P.,	London, England.
Victor A. H. Horsley, Esq., F.R.C.S.,	London, England.
L. C. Lane, M.D., LL.D.,	San Francisco, California.
Dr. Rafael Lavista, Prof. of Surgery,	City of Mexico.
Sir William MacCormac, F.R.C.S.I., F.R.C.S. Eng.,	London, England.
William M. Ord, M.D., F.R.C.P.,	London, England.
William O. Priestley, M.D., LL.D., F.R.C.P. Edinb.,	London, England.
P. H. Pye-Smith, M.D., F.R.C.P.,	London, England.
Dr. J. W. Rosebrugh,	Hamilton, Ontario.
Arthur Ernest Sansom, M.D., F.R.C.P.,	London, England.
Dr. Francis I. Shepherd,	Montreal, Canada.
W. I. Sinclair, Esq., M.D.,	Manchester, England.
Sir Spencer Wells, Bart., F.R.C.S., Eng.,	London, England.

The following Fellows or Members were present at the meetings of their respective Associations or Societies.

FROM THE
AMERICAN OPHTHALMOLOGICAL SOCIETY. 1864.

Dr. Swan M. Burnett,	Washington, D. C.
Dr. Peter A. Callan,	New York City.
Dr. William H. Carmalt,	New Haven, Connecticut.
Dr. David C. Cocks,	New York City.
Dr. Richard H. Derby,	New York City.
Dr. William S. Dennett,	New York City.
Dr. John Green,	St. Louis, Missouri.
Dr. Howard F. Hansell,	Philadelphia, Pennsylvania.
Dr. Edward E. Holt,	Portland, Maine.
Dr. Edward Jackson,	Philadelphia, Pennsylvania.
Dr. Charles W. Kollock,	Charleston, South Carolina.
Dr. Francis B. Loring,	Washington, D. C.
Dr. W. V. Marmion,	Washington, D. C.
Dr. B. L. Milliken,	Cleveland, Ohio.
Dr. W. F. Mittendorf,	New York City.
Dr. Henry D. Noyes,	New York City.
Dr. Chas. A. Oliver,	Philadelphia, Pennsylvania.
Dr. Oren D. Pomeroy,	New York City.
Dr. Jonathan S. Prout,	Brooklyn, New York.
Dr. S. O. Richey,	Washington, D. C.
Dr. Samuel B. St. John,	Hartford, Connecticut.
Dr. W. W. Seely,	Cincinnati, Ohio.
Dr. J. Oscroft Tansley,	New York City.
Dr. Lewis H. Taylor,	Wilkes-Barre, Pennsylvania.
Dr. Samuel Theobald,	Baltimore, Maryland.
Dr. William Thomson,	Philadelphia, Pennsylvania.
Dr. John Van Duyn,	Syracuse, New York.
Dr. J. J. B. Vermyne,	New Bedford, Massachusetts.
Dr. David Webster,	New York City.
Dr. Henry W. Williams,	Boston, Massachusetts.
Dr. F. M. Wilson,	Bridgeport, Connecticut.

FROM THE
AMERICAN OTOLOGICAL SOCIETY. 1868.

Dr. Gorham Bacon,	New York City.
Dr. Charles H. Burnett,	Philadelphia, Pennsylvania.
Dr. Wm. H. Carmalt,	New Haven, Connecticut.
Dr. John Green,	St. Louis, Missouri.
Dr. E. E. Holt,	Portland, Maine.
Dr. Francis B. Loring,	Washington. D. C.
Dr. Henry D. Noyes,	New York City.
Dr. Oren D. Pomeroy,	New York City.
Dr. J. S. Prout,	Brooklyn, New York.

Dr. S. O. Richey,	Washington, D. C.
Dr. W. W. Seeley,	Cincinnati, Ohio.
Dr. Samuel Sexton,	New York City.
Dr. J. Oscroft Tansley,	New York City.
Dr. Samuel Theobald,	Baltimore, Maryland.
Dr. William Thomson,	Philadelphia, Pennsylvania.
Dr. J. J. B. Vermyne,	New Bedford, Massachusetts.
Dr. David Webster,	New York City.
Dr. F. M. Wilson,	Bridgeport, Connecticut.

FROM THE

AMERICAN NEUROLOGICAL ASSOCIATION. 1875.

Dr. Samuel Ayres,	Pittsburgh, Pennsylvania.
Dr. Henry M. Baumster,	Kankakee Illinois.
Dr. Edward N. Brush,	Philadelphia, Pennsylvania.
Dr. Charles L. Dana,	New York City.
Dr. F. X. Dercum,	Philadelphia, Pennsylvania.
Dr. Robt. T. Edes,	Washington, D. C.
Dr. E. D. Fisher,	New York City.
Dr. V. P. Gibney,	New York City.
Dr. Landon Carter Gray,	New York City.
Dr. Græme M. Hammond,	New York City.
Dr. William A. Hammond.	New York City.
Dr. Henry Hun,	Albany, New York.
Dr. David Inglis,	Detroit, Michigan.
Dr. George W. Jacoby,	New York City.
Dr. Philip C. Knapp,	Boston, Massachusetts.
Dr. James H. Lloyd,	Philadelphia, Pennsylvania.
Dr. S. J. McNutt,	New York City.
Dr. Francis S. Miles,	Baltimore, Maryland.
Dr. Charles R. Mills,	Philadelphia, Pennsylvania.
Dr. Isaac Ott,	Easton, Pennsylvania.
Dr. Ralph S. Parsons,	Sing Sing, New York.
Dr. Frederick Peterson,	New York City.
Dr. James J. Putnam,	Boston, Massachusetts.
Dr. Irving C. Ross,	Washington, D. C.
Dr. B. Sachs,	New York City.
Dr. E. C. Seguin,	New York City.
Dr. Wharton Sinkler,	Philadelphia, Pennsylvania.
Dr. M. Allen Starr,	New York City.
Dr. Henry R. Stedman,	Boston, Massachusetts.
Dr. I. Van Bibber,	Baltimore, Maryland.
Dr. George L. Walton,	Boston, Massachusetts.
Dr. S. G. Webber,	Boston, Massachusetts.
Dr. Philip Zenner,	Cincinnati, Ohio.

FROM THE

AMERICAN GYNÆCOLOGICAL SOCIETY. 1876.

Dr. T. A. Ashley,	Baltimore, Maryland.
Dr. B. F. Baer,	Philadelphia, Pennsylvania.
Dr. W. H. Baker,	Boston, Massachusetts.
Dr. Fordyce Barker,	New York City.
Dr. Robert Battey,	Rome, Georgia.
Dr. B. Bernard Browne,	Baltimore, Maryland.
Dr. Samuel C. Busey,	Washington, D. C.
Dr. John Byrne,	Brooklyn, New York.
Dr. Thomas M. Drysdale,	Philadelphia, Pennsylvania.
Dr. E. L. Duer,	Philadelphia, Pennsylvania.
Dr. E. C. Dudley,	Chicago, Illinois.
Dr. Bache McE. Emmet,	New York City.
Dr. Geo. J. Engleman,	St. Louis, Missouri.
Dr. H. J. Garrigues,	New York City.
Dr. William Goodell,	Philadelphia, Pennsylvania.
Dr. Charles M. Green,	Baltimore, Maryland.
Dr. H. T. Hanks,	New York City.
Dr. James B. Hunter,	New York City.
Dr. J. E. Janvrin,	New York City.
Dr. Charles Jewett,	Brooklyn, New York.
Dr. Joseph T. Johnson,	Washington, D. C.
Dr. A. W. Johnstone,	Danville, Kentucky.
Dr. Edward W. Jenks,	Detroit, Michigan.
Dr. A. F. A. King,	Washington, D. C.
Dr. H. A. Kelly,	Philadelphia, Pennsylvania.
Dr. Cornelius Kollock,	Cheraw, South Carolina.
Dr. Wm. T. Lusk,	New York City.
Dr. Matthew D. Mann,	Buffalo, New York.
Dr. W. H. Parish,	Philadelphia, Pennsylvania.
Dr. Theophilus Parvin,	Philadelphia, Pennsylvania.
Dr. W. M. Polk,	New York City.
Dr. T. A. Reamey,	Cincinnati, Ohio.
Dr. J. C. Reeve,	Dayton, Ohio.
Dr. Edward Warren Sawyer,	Chicago, Illinois.
Dr. H. Marion Sims,	New York City.
Dr. Alex. J. C. Skene,	Brooklyn, New York.
Dr. R. S. Sutton,	Pittsburg, Pennsylvania.
Dr. T. Gaillard Thomas,	New York City.
Dr. Ely Van de Warker,	Syracuse, New York.
Dr. H. P. C. Wilson,	Baltimore, Maryland.
Dr. W. Gill Wylie,	New York City.

FROM THE

AMERICAN DERMATOLOGICAL ASSOCIATION. 1876.

Dr. I. E. Atkinson,	Baltimore, Maryland.
Dr. Edward Bennett Bronson,	New York City.
Dr. L. Duncan Bulkley,	New York City.

Dr. George Henry Fox,	New York City.
Dr. I. E. Graham,	Toronto, Canada.
Dr. C. Heitzmann,	New York City.
Dr. James Nevins Hyde,	Chicago, Illinois.
Dr. Robert B. Morrison,	Baltimore, Maryland.
Dr. Prince A. Morrow,	New York City.
Dr. A. R. Robinson,	New York City.
Dr. George A. Rohé,	Baltimore, Maryland.
Dr. S. Sherwell,	Brooklyn, New York.
Dr. Henry W. Stelwagon,	Philadelphia, Pennsylvania.
Dr. R. W. Taylor,	New York City.
Dr. G. H. Tilden,	Boston, Massachusetts.
Dr. Arthur Van Harlingen,	Philadelphia, Pennsylvania.

FROM THE
AMERICAN LARYNGOLOGICAL ASSOCIATION. 1878.

Dr. Harrison Allen,	Philadelphia, Pennsylvania.
Dr. F. H. Bosworth,	New York City.
Dr. J. Solis Cohn,	Philadelphia, Pennsylvania.
Dr. S. Solis Cohn,	Philadelphia, Pennsylvania.
Dr. William H. Daly,	Pittsburgh, Pennsylvania.
Dr. D. Bryson Delavan,	New York City.
Dr. F. Donaldson,	Baltimore, Maryland.
Dr. T. R. French,	Brooklyn, New York.
Dr. Wm. C. Glasgow,	St. Louis, Missouri.
Dr. F. Whitehill Hinkel,	Buffalo, New York.
Dr. Edgar Holden,	Newark, New Jersey.
Dr. Franklin H. Hooper,	Boston, Massachusetts.
Dr. E. Fletcher Ingals,	Chicago, Illinois.
Dr. William C. Jarvis,	New York City.
Dr. H. A. Johnson,	Chicago, Illinois.
Dr. Samuel Johnston,	Baltimore, Maryland.
Dr. Charles K. Knight,	New York City.
Dr. Frederick I. Knight,	Boston, Massachusetts.
Dr. Samuel W. Langmaid,	Boston, Massachusetts.
Dr. George M. Lefferts,	New York City.
Dr. Rufus P. Lincoln,	New York City.
Dr. Alexander W. MacCoy,	Philadelphia, Pennsylvania.
Dr. John N. Mackenzie,	Baltimore, Maryland.
Dr. E. Carroll Morgan,	Washington, D. C.
Dr. G. C. Mulhall,	St. Louis, Missouri.
Dr. Clarence C. Rice,	New York City.
Dr. Beverly Robinson,	New York City.
Dr. John O. Roe,	Buffalo, New York.
Dr. Charles E. Sajous,	Philadelphia, Pennsylvania.
Dr. Carl Seiler,	Philadelphia, Pennsylvania.
Dr. Ernest L. Shurley,	Detroit, Michigan.
Dr. S. O. Van Der Poel,	New York City.
Dr. Benjamin F. Westbrook,	Brooklyn, New York.

FROM THE

AMERICAN SURGICAL ASSOCIATION. 1880.

Dr. D. Hayes Agnew,	Philadelphia, Pennsylvania.
Dr. John Ashhurst, Jr.,	Philadelphia, Pennsylvania.
Dr. John S. Billings,	Washington, D. C.
Dr. R. B. Bontecou,	Troy, New York.
Dr. D. D. Bramble,	Cincinnati, Ohio.
Dr. W. T. Briggs,	Nashville, Tenn.
Dr. Wm. T. Bull,	New York City.
Dr. Wm. H. Carmalt,	New Haven, Conn.
Dr. David W. Cheever,	Boston, Massachusetts.
Dr. P. S. Conner,	Cincinnati, Ohio.
Dr. N. P. Dandridge,	Cincinnati, Ohio.
Dr. Frederick S. Dennis,	New York City.
Dr. William S. Forbes,	Philadelphia, Pennsylvania.
Dr. George W. Gay,	Boston. Massachusetts.
Dr. Samuel W. Gross,	Philadelphia, Pennsylvania.
Dr. William Hunt,	Philadelphia, Pennsylvania.
Dr. Ralph N. Isham,	Chicago, Illinois.
Dr. Christopher Johnston,	Baltimore, Maryland.
Dr. Wm. W. Keen,	Philadelphia, Pennsylvania.
Dr. R. A. Kinloch,	Charleston, South Carolina.
Dr. R. J. Levis,	Philadelphia, Pennsylvania.
Dr. James McCann,	Pittsburgh, Pennsylvania.
Dr. Hunter McGuire.	Richmond, Virginia.
Dr. Claudius H. Mastin,	Mobile, Alabama.
Dr. William M. Mastin,	Mobile, Alabama.
Dr. J. Ewing Mears,	Philadelphia, Pennsylvania.
Dr. J. Edwin Michael,	Baltimore, Maryland.
Dr. E. M. Moore,	Rochester, New York.
Dr. Thomas G. Morton,	Philadelphia, Pennsylvania.
Dr. Henry H. Mudd,	St. Louis, Missouri.
Dr. Chas. B. Nancrede,	Philadelphia, Pennsylvania.
Dr. John G. Owens,	Chicago, Illinois.
Dr. John H. Packard,	Philadelphia, Pennsylvania.
Dr. Wm. H. Pancoast,	Philadelphia, Pennsylvania.
Dr. Roswell Park,	Buffalo, New York.
Dr. Charles T. Parkes,	Chicago, Illinois.
Dr. William T. Peck,	Davenport, Iowa.
Dr. T. F. Prewitt,	St. Louis, Missouri.
Dr. David Prince,	Jacksonville, Illinois.
Dr. Joseph Ransohoff,	Cincinnati, Ohio.
Dr. Thomas B. Reed,	Philadelphia. Pennsylvania.
Dr. Maurice H. Richardson,	Boston, Massachusetts.
Dr. John B. Roberts,	Philadelphia, Pennsylvania.
Dr. Thomas P. Russell,	Oshkosh, Wisconsin.
Dr. Lewis A. Sayre,	New York City.
Dr. Nicholas Senn,	Milwaukee, Wisconsin.
Dr. J. Ford Thompson,	Washington, D. C.

Dr. Wm. Thomson,	Philadelphia, Pennsylvania.
Dr. Louis McLane Tiffany,	Baltimore, Maryland.
Dr. Albert Van Der Veer,	Albany, New York.
Dr. J. Collins Warren,	Baltimore, Maryland.
Dr. B. A. Watson,	Jersey City, New Jersey.
Dr. J. R. Weist,	Richmond, Indiana.
Dr. DeForest Willard,	Philadelphia, Pennsylvania.

FROM THE

AMERICAN CLIMATOLOGICAL ASSOCIATION. 1883.

Dr. J. M. Anders,	Philadelphia, Pennsylvania.
Dr. F. H. Bosworth,	New York City.
Dr. V. Y. Bowditch,	Boston, Massachusetts.
Dr. Leroy I. Brooks.	Norwich, New York.
Dr. Edward T. Bruen,	Philadelphia, Pennsylvania.
Dr. D. M. Camman,	New York City.
Dr. J. Solis Cohen,	Philadelphia, Pennsylvania.
Dr. Roland G. Curtin,	Philadelphia, Pennsylvania.
Dr. William Hudson Daly,	Pittsburg, Pennsylvania.
Dr. Charles Dennison,	Denver, Colorado.
Dr. W. E. Ford,	Utica, New York.
Dr. W. S. Giddings,	Aiken, South Carolina.
Dr. William C. Glasgow,	St. Louis, Missouri.
Dr. E. Fletcher Ingals,	Chicago, Illinois.
Dr. David Inglis,	Detroit, Michigan.
Dr. W. C. Jarvis,	New York City.
Dr. Walter A. Jayne,	Georgetown, Colorado.
Dr. H. A. Johnson,	Chicago, Illinois.
Dr. W. W. Johnston,	Washington, D. C.
Dr. Frederick I. Knight,	Boston, Massachusetts.
Dr. Paul H. Ketzshmar,	Brooklyn, New York.
Dr. Thomas I. Latimer,	Baltimore, Maryland.
Dr. James K. Leaming,	New York City.
Dr. James I. Levick,	Philadelphia, Pennsylvania.
Dr. Alfred L. Loomis,	New York City.
Dr. Washington Matthews,	U. S. Army.
Dr. E. Carroll Morgan,	Washington, D. C.
Dr. John H. Musser,	Philadelphia, Pennsylvania.
Dr. R. C. M. Page,	New York City.
Dr. William Pepper,	Philadelphia, Pennsylvania.
Dr. J. H. Platt,	Lakewood, New Jersey.
Dr. Boardman Reed,	Atlantic City, New Jersey.
Dr. J. Harvey Reed,	Mansfield, Ohio.
Dr. Clarence C. Rice,	New York City.
Dr. Beverly Robinson,	New York City.
Dr. George H. Rohé,	Baltimore, Maryland.
Dr. Edward W. Schauffer,	Kansas City, Missouri.
Dr. Frederick C. Shattuck,	Boston, Massachusetts.
Dr. Ernest L. Shurley,	Detroit, Michigan.

Dr. Andrew H. Smith,	New York City.
Dr. Frank F. Smith,	St. Augustine, Florida.
Dr. S. E. Solly,	Colorado Springs, Colorado.
Dr. James Carey Thomas,	Baltimore, Maryland.
Dr. W. C. Van Bibber,	Baltimore, Maryland.
Dr. James B. Walker,	Philadelphia, Pennsylvania.
Dr. Samuel B. Ward,	Albany, New York.
Dr. Benjamin F. Westbrook,	Brooklyn, New York.
Dr. James F. Whitaker,	Cincinnati, Ohio.
Dr. Herbert F. Williams,	Brooklyn, New York.
Dr. James C. Wilson,	Philadelphia, Pennsylvania.

FROM THE

ASSOCIATION OF AMERICAN PHYSICIANS. 1885.

Dr. J. F. A. Adams,	Pittsfield, Massachusetts.
Dr. I. E. Atkinson,	Baltimore, Maryland.
Dr. G. Baumgarten,	St. Louis, Missouri.
Dr. Edward T. Bruen,	Philadelphia, Pennsylvania.
Dr. Samuel C. Busey,	Washington, D. C.
Dr. Samuel C. Chew,	Baltimore, Maryland.
Dr. W. T. Councilman,	Baltimore, Maryland.
Dr. J. M. Da Costa,	Philadelphia, Pennsylvania.
Dr. Israel T. Dana,	Portland, Maine.
Dr. Francis T. Delafield,	New York City.
Dr. F. Donaldson,	Baltimore, Maryland.
Dr. Wm. H. Draper,	New York City.
Dr. Robert T. Edes,	Washington, D. C.
Dr. Reginald H. Fitz,	Boston, Massachusetts.
Dr. F. Forchheimer,	Cincinnati, Ohio.
Dr. Henry F. Formad,	Philadelphia, Pennsylvania.
Dr. J. E. Graham,	Toronto, Canada.
Dr. I. Minis Hays,	Philadelphia, Pennsylvania.
Dr. Henry Hun,	Albany, New York.
Dr. James H. Hutchinson,	Philadelphia, Pennsylvania.
Dr. Abraham Jacobs,	New York City.
Dr. E. G. Janeway,	New York City.
Dr. H. A. Johnson,	Chicago, Illinois.
Dr. W. W. Johnston,	Washington, D. C.
Dr. Francis P. Kinnicutt,	New York City.
Dr. Alfred L. Loomis,	New York City.
Dr. Wm. T. Lusk,	New York City.
Dr. Henry M. Lyman,	Chicago, Illinois.
Dr. Arthur V. Meigs,	Philadelphia, Pennsylvania.
Dr. Francis T. Miles,	Baltimore, Maryland.
Dr. Francis Minot,	Boston, Massachusetts.
Dr. J. H. Musser,	Philadelphia, Pennsylvania.
Dr. William Osler,	Philadelphia, Pennsylvania.
Dr. Geo. L. Peabody,	New York City.
Dr. William Pepper,	Philadelphia, Pennsylvania.

Dr. Wm. M. Polk,	New York City.
Dr. F. Peyre Porcher,	Charleston, South Carolina.
Dr. T. Mitchell Prudden,	New York City.
Dr. J. J. Putnam,	Boston, Massachusetts.
Dr. James E. Reeves,	Chattanooga, Tennessee.
Dr. Beverly Robinson,	New York City.
Dr. George Ross,	Montreal, Canada.
Dr. E. C. Seguin,	New York City.
Dr. Edward O. Shakespeare,	Philadelphia, Pennsylvania.
Dr. Frederick C. Shattuck,	Boston, Massachusetts.
Dr. Wharton Sinkler,	Philadelphia, Pennsylvania.
Dr. S. E. Solly,	Colorado Springs, Colorado.
Dr. Louis Starr,	Philadelphia, Pennsylvania.
Dr. M. Allen Starr,	New York City.
Dr. Geo. M. Sternberg,	Baltimore, Maryland.
Dr. James Stewart,	Montreal, Canada.
Dr. James K. Thacher,	New Haven, Connecticut.
Dr. James Tyson,	Philadelphia, Pennsylvania.
Dr. Samuel B. Ward,	Albany, New York.
Dr. William H. Welch,	Baltimore, Maryland.
Dr. James F. Whitaker,	Cincinnati, Ohio.
Dr. George Wilkins,	Montreal, Canada.
Dr. James C. Wilson,	Philadelphia, Pennsylvania.
Dr. H. C. Wood,	Philadelphia, Pennsylvania.

FROM THE
AMERICAN ASSOCIATION OF GENITO-URINARY SURGEONS. 1886.

Dr. L. Bolton Bangs,	New York City.
Dr. Charles F. Bevan,	Baltimore, Maryland.
Dr. John P. Bryson,	St. Louis, Missouri.
Dr. E. C. Burnett,	St. Louis, Missouri.
Dr. A. T. Cabot,	Boston, Massachusetts.
Dr. George Chesmire,	San Francisco, California.
Dr. Algernon S. Garnett,	Hot Springs, Arkansas.
Dr. Samuel W. Gross,	Philadelphia, Pennsylvania.
Dr. W. H. Hingston,	Montreal, Canada.
Dr. James Nevins Hyde,	Chicago, Illinois.
Dr. Edward L. Keyes,	New York City.
Dr. Edmund C. King,	Toronto, Canada.
Dr. Claudius H. Mastin,	Mobile, Alabama.
Dr. William M. Mastin,	Mobile, Alabama.
Dr. J. Edwin Michael,	Baltimore, Maryland.
Dr. P. A. Morrow,	New York City.
Dr. E. R. Palmer,	Louisville, Kentucky.
Dr. Roswell Park,	Buffalo, New York.
Dr. Abner Post,	Boston, Massachusetts.
Dr. F. N. Otis,	New York City.
Dr. Frank W. Rockwell,	Brooklyn, New York.
Dr. Alex. W. Stein,	New York City.

Dr. F. R. Sturgis,	New York City.
Dr. R. W. Taylor,	New York City.
Dr. G. H. Tilden,	Boston, Massachusetts.
Dr. Francis S. Watson,	Boston, Massachusetts.
Dr. Robert F. Weir,	New York City.

FROM THE
AMERICAN ORTHOPEDIC ASSOCIATION. 1887.

Dr. E. H. Bradford,	Boston, Massachusetts.
Dr. V. P. Gibney,	New York City.
Dr. H. Hodgen,	St. Louis, Missouri.
Dr. A. B. Judson,	New York City.
Dr. Samuel Ketch,	New York City.
Dr. Benjamin Lee,	Philadelphia, Pennsylvania.
Dr. Robert W. Lovett,	Boston, Massachusetts.
Dr. James E. Moore,	Minneapolis, Minnesota.
Dr. Geo. B. Packard,	Hartford, Connecticut.
Dr. Roswell Park,	Buffalo, New York.
Dr. John Ridlon,	New York City.
Dr. George W. Ryan,	Cincinnati, Ohio.
Dr. Lewis Hall Sayre,	New York City.
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THE DIAGNOSIS AND MEDICAL TREATMENT OF ACUTE INTESTINAL OBSTRUCTION.

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IN the consideration of intestinal obstruction from a medical point of view, the subjects of chiefest importance undoubtedly relate to diagnosis and treatment.

The present communication is intended to call attention to those features which may possibly serve to characterize the former, and to mark the limits of the latter up to the point of surgical interference. It will be admitted without much question that the difficulties of exact diagnosis, and the possibilities of permanent relief, are greatest in acute, internal forms of obstruction. It is, therefore, to this part of the subject, in particular, that the present enquiry is directed.

The term intestinal obstruction would seem to be equivalent to stoppage of the bowels, and refers to the absence of an important function of this apparatus. The conspicuous causes of such a stoppage are essentially mechanical, and the anatomist finds the bands and cords, the slits and pouches, the invaginations, twists and knots, the strictures, tumors, and abnormal contents.

But in another class of cases the stoppage is present, the patient dies, and there is not found an entirely satisfactory, mechanical cause of obstruction. If the intestinal coils are agglutinated or adherent in such a manner that valve-like projections into the canal are formed, these are considered by some a satisfactory explanation of the symptom. If the mesentery of any coil is so contracted that the legs of the loop are closely approximated, this change is frequently considered a sufficient cause. But agglutinated and adherent coils are frequently found in the absence of symptoms of intestinal obstruction, and the contracted mesentery is seen in cases where no stoppage of the bowels has occurred.

This symptom takes place in still another series of cases where the anatomist finds no suggestion of a lesion which offers the remotest possibility of acting as a mechanical cause. The physician then says the obstruction must be due to a paralysis of the muscular coat, or a spasm of the circular fibres, or a faulty innervation, or to some peculiar modification of function.

Intestinal obstruction, in a technical sense, however, means something more than stoppage of the bowels. The latter symptom may be present at the outset, it may occur later in the course of the disease, or frequent loose movements may be a most characteristic symptom of the especial variety of obstruction, as in intussusception. Frequent dejections may also occur in the early stages of other varieties of obstruction, and throughout the course of the disease when fæces are the cause. Stoppage of the bowels is thus not only unnecessary as a symptom of intestinal obstruction, but, when present, its particular consideration has led to frequent errors of diagnosis. Of all the causes of stoppage, which have given rise to an erroneous diagnosis of obstruction, there is none more frequent than peritonitis.

In a general peritonitis the bowels are expected to remain inactive, and medical efforts are frequently directed to this result. In the circumscribed variety the important symptoms of localized pain and paralyzed bowels have often led to the diagnosis of acute, internal obstruction. This is particularly true in the case of inflammation of the vermiform appendix, a disease which is constantly being mistaken for acute obstruction. This error in diagnosis leads to corresponding errors in treatment. Because the bowels have been opened in such cases by powerful cathartics, quicksilver, electricity, violent movements of the body, and the like, therefore these are claimed to be valuable and efficient remedies in intestinal obstruction. Too often the speedy death of the patient results from such treatment, the local peritonitis being made general.

The only intestinal obstruction which deserves the joint consideration of surgeons and physicians is that due to well-recognized, mechanical causes. It is the acute, internal variety of mechanical, intestinal obstruction which forms the subject of this paper.

There are four main questions which require consideration in any given instance:

First, Is the case one of acute, internal obstruction?

Second, Where is the obstruction seated?

Third, What is the variety?

Fourth, What is to be done?

The statements which follow in this paper are essentially based upon the study of a series of cases collected from the English, German, and French medical literature since 1880. Its claim to consideration lies in the fact that all the cases have been submitted to the severest criticism, with the resulting exclusion of a very large number. They are included under the heads of strangulation by bands, cords, etc., intussusception, knots and twists, obstruction by abnormal contents, strictures, and tumors. The entire number is two hundred and ninety-five, and they are divided as follows :

Strangulation	101 cases	= 34 per cent.
Intussusception	93 "	= 32 "
Abnormal contents	44 "	= 15 "
Twists and knots	42 "	= 14 "
Strictures and tumors	15 "	= 5 "
	295 "	100 "

Excluding from this series the cases of acute obstruction from abnormal contents and from strictures and tumors, which are of the least importance in practice, there remain

Strangulation	101 cases	= 43 per cent.
Intussusception	93 "	= 39 "
Twists and knots	42 "	= 18 "
	236 "	100 "

It is interesting to compare these figures with the larger number in the collections of Duchaussoy,* Brinton,† and Leichtenstern :‡

Percentage of relative frequency of the more prominent causes of acute, intestinal obstruction.	Number of cases included.	Strangulation.	Intussusception.	Twists and Knots.
Duchaussoy	347	54	39	6
Brinton	481	33	54§	10
Leichtenstern	1134	35	39	6

STRANGULATION.

First in numerical importance as a cause of acute, intestinal obstruction is strangulation by bands or cords.

These are most frequently the result of a pre-existing peritonitis, and are either fibrous adhesions alone, or are formed by adherent appendages of the intestinal or genital tract. The former are epiploic, vermiform, diverticular, omental, or mesenteric. The latter are Fallopian tubes and pedunculate ovarian or uterine tumors. The diverticular appendages are either Meckel's diverticulum (the omphalo-mesenteric or vitelline duct), or the persistent remains of the vitelline blood-vessels. The former is usually attached by the latter to some part of the abdominal wall or contents. It may also be thus attached from peritonitis, in the absence of the latter. The persistent vitelline blood-vessels or their remains may likewise form the strangulating cord in the absence of the diverticulum. Omental cords may be adherent in consequence of peritonitis, or they may result from the presence of slits or fissures of the omentum. The mesentery serves as a cause of strangulation when it is fissured by a slit. Peritoneal pouches and openings may be added to the above list.

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* Duchaussoy, Mémoirs de l'Académie Impériale de Médecine, 1850, xxiv. 97.

† Brinton, Intestinal Obstruction, 1867, 88.

‡ Leichtenstern, Ziemssen's Handb. d. Sp. Path. und Therapie, 1876, vii. 2, 528.

§ Brinton gives forty-three per cent. of intussusception in his table of six hundred cases of intestinal obstruction by this lesion, bands, adhesions, diverticula, or peritoneum external to the bowel, strictures (including a few tumors) involving the intestinal wall, and torsion of the bowel on its axis. *Op. cit.*, 38.

There seems to be no essential difference in the nature of the symptoms which arise from these causes of obstruction. Cases of knots and twists of the small intestine might be added to the list from the nature of their symptoms, but their number is so small, only two of each, that for practical purposes they may be omitted.

The immediate anatomical causes of the one hundred and one cases of strangulation are as follows, the numbers being regarded as equivalent to percentages:

Adhesions	63	cases.
Vitelline remains	21	"
Adherent appendix	6	"
Mesenteric and omental slits	6	"
Peritoneal pouches and openings	3	"
Adherent tube	1	"
Pedunculate tumor	1	"
	101	"

Eighty-four per cent. of the total number of cases were due to bands and cords in a limited sense. It is noteworthy that cases of diaphragmatic hernia, which form 19% of Leichtenstern's cases, were not reported in the past eight years.

The following table shows the bearing of sex in the frequency of obstruction from strangulation:

	Adhesions.	Vitelline Remains.	Appendix.	Slits.	Pouches.	Tube.	Tumors.	Total.
Males	39	19	5	5	2			70
Females	24	1	1	1	1	1	1	30
	63	20	6	6	3	1	1	100

It thus appears that 70% of the cases of obstruction from strangulation occurred among males. Further, that nearly all the cases of obstruction from vitelline remains, adherent appendices, and slits were found among men. The percentage of bands of intestinal origin and those of pelvic origin was about equal in the two sexes.

The age at which the obstruction took place is shown in the following table :

Years of Age.	Adhesions.	Vitelline Remains.	Appendix.	Slits.	Pouches.	Tube.	Total.
1- 5	--	2	--	--	--	--	2
5-10	--	3	1	--	--	--	4
10-15	2	2	1	--	--	--	5
15-20	6	2	--	1	--	--	9
20-25	12	5	--	--	--	--	17
25-30	8	4	1	1	--	--	14
30-35	4	--	--	2	--	--	6
35-40	1	1	1	--	--	--	3
40-45	6	--	1	--	--	--	7
45-50	2	--	--	--	--	--	2
50-55	7	--	1	--	--	--	8
55-60	1	--	--	1	2	1	5
60-65	3	--	--	1	--	--	4
65-70	2	--	--	--	--	--	2
70-75	1	--	--	--	--	--	1
	55	19	6	6	2	1	89

Strangulation in early youth was, hence, relatively uncommon. When it occurs it is most likely to result from vitelline remains. At least 40% of the cases of strangulation occurred between the ages of fifteen and thirty years, and adhesions as the cause of the same were more than twice as frequent as vitelline remains. After the age of thirty years adhesive bands are the usual cause.

In the etiology of adhesions a record of previous peritonitis, or perityphlitis, was found in ten of the cases, about one-sixth of all, and of an associated hernia in seven instances. In a small fraction errors in diet, violent muscular exercise, blows upon the abdomen, surgical operations for pelvic caries and cancer of the bowels, were important in the etiology.

In nearly one-half of the cases of vitelline remains previous attacks of abdominal pain were recorded, and in one instance there was the history of a yellowish discharge from the navel in infancy. One-half of the cases of adherent appendix were preceded by an attack of perityphlitis. Evidence of a pre-existing attack of intestinal obstruction was found in one case of mesenteric slit; another was preceded by chronic dysentery for a year. A case of protrusion of the intestine through an opening in the coronary ligament suffered, three years before, from a severe attack of inflammation of the bowels, with intervening colic and repeated diarrhœa. The immediate attack of obstruction in two cases of mesenteric slit followed a fit of coughing in the one and took place at stool in the other.

Evidence of antecedent peritonitis thus existed in 13% of the cases, the band then being an adhesion or an appendix. In 7% of the cases a hernia was associated with the band. In 80% of the cases there was no factor of diagnostic importance.

Abdominal pain was the first important symptom noticed in 82% of all the cases of strangulation. The percentage of its frequency in each variety of strangulation is shown as follows :—

In Adhesions	in	50	cases	= 79	per cent. of all the cases.	
" Vitelline remains	"	18	"	= 86	"	" "
" Adherent appendix	"	6	"	=100	"	" "
" Slits	"	6	"	=100	"	" "
" Pouches and openings	"	2	"	= 66	"	" "
		82				

It was usually sudden, severe, rarely slight, and was described as colicky. It was only exceptionally accompanied, at the outset, with tenderness. In the majority of cases it was simply stated to be abdominal.

It was located at the navel in eight instances, at the epigastrium in five, in the right iliac fossa in four, at the hepatic flexure and in the right hypochondrium each in three cases, in the left iliac fossa in two, in the lumbar region, splenic flexure, along the spermatic cord, and in the spine and back each in one case. An exact localization of the incipient pain was thus recorded in 29% of all the cases. There seems to be no diagnostic importance to be attached to the seat of pain as evidence of strangulation, or of its special cause, as will become apparent when the seat of the obstruction is stated.

The initial pain was found to be early associated with nausea or vomiting, either alone or together, in 69% of the cases. The date of appearance, and the frequency in the special varieties of strangulation are given in the following table :—

Date.	Adhesions.	Vit. remains.	Appendix.	Slits.	Pouches, etc.	Total.
1st day	21	13	5	2	1	42
2nd "	7	4	1	1	--	13
3rd "	2	--	--	1	--	3
4th "	2	--	--	--	1	3
5th "	1	--	--	--	--	1
Not given	7	--	--	--	--	7
	40	17	6	4	2	69

A comparison of these figures shows the occurrence of this symptom on the first day in 68% of those cases in which it was possible to determine the date with accuracy. It took place on the first day in at least one-third of the cases of adhesions, in more than one-half of those of vitelline remains, in five-sixths of those of peritoneal slit. The proportion is evidently much greater when the number of cases is considered in which the date of occurrence could be definitely ascertained. The relative frequency then becomes more than one-half in the case of adhesions, two-thirds in those of vitelline remains, five-sixths in adherent appendix, and one-half in strangulation by a slit.

Its occurrence on the first day is most suggestive of an adhesion, a vitelline cord or diverticulum, an appendix, a slit, or a pouch, in the order stated.

The occasional absence of nausea or vomiting is noteworthy, and is mentioned in two cases of strangulation by adhesions, one of which terminated fatally, the other in recovery, after laparotomy.

The vomit, as in all cases of intestinal obstruction, was usually composed, at the outset, of the food last taken. It then became mixed with bile, eventually yellow, and finally fecal. It was frequently noticed that the vomiting only became constant when material was persistently taken into the stomach.

Fecal vomit is a term which is somewhat loosely applied, and is in no way to be regarded as other than conventional. There was no evidence to warrant the idea that the contents of the large intestine were ever vomited. The distinction between the yellow vomit and the fecal or stercoraceous variety seems to depend chiefly upon the length of time during which a pyloric insufficiency has existed. It is quite probable that among the records of fecal vomit are those in which this term was applied to the ejection of a yellow, odorless, intestinal fluid. The term should be more exclusively applied to the offensive ejections which have remained sufficiently long above the point of obstruction to become fetid. The following table shows the date of this intestinal vomit in thirty-seven cases :—

Date.	Adhesions.	Vit. remains.	Appendix.	Slits.	Total.
2nd day	2	2	--	--	4
3rd "	4	2	2	--	8
4th "	3	1	--	--	4
5th "	6	--	--	1	7
6th "	2	3	--	--	5
7th "	2	1	--	--	3
8th "	1	--	--	--	1
9th "	2	--	--	--	2
10th "	1	1	--	--	2
13th "	--	--	--	1	1
Not given	5	4	1	--	10
	28	14	3	2	47

The vomit thus became fecal most often on the third and fifth days, although on these dates in only about one-fifth of the cases in which definite dates were given.

Tympany is next in importance to abdominal pain and vomit as a symptom of obstruction from strangulation. Its occurrence in 56% of all cases is recorded, and the date of its appearance is given as follows :—

DATE.	Adhesions.	Vit. remains.	Appendix.	Slits.	Pouches.	Total.
1st day	2	--	--	--	--	2
2nd "	2	1	2	1	--	6
3rd "	4	2	1	1	--	8
4th "	4	2	--	1	1	8
5th "	4	2	1	--	--	7
6th "	5	2	--	--	1	8
7th "	2	1	--	--	--	3
8th "	1	--	--	--	--	1
9th "	--	1	--	--	--	1
10th "	--	1	--	--	--	1
11th "	2	--	--	--	--	2
13th "	2	--	--	--	--	2
Not given	4	1	1	1	--	7
	32	13	5	4	2	56

Tympanitic distention of the abdomen thus occurred in more than one-half of the cases of strangulation, and was most frequent from the second to the sixth days inclusive. It may be wholly absent as late as the eighth day, and may be much on the first day. It was sometimes enormous during the first week, but much more often slight or moderate. The distended abdomen was not especially tender to the touch.

An abdominal tumor was sometimes noticed in cases of strangulation, and a distinction is to be drawn between tympany and tumor, although tympanitic intestines may be the cause of each. Under the general head, tumor, are included circumscribed, distended, visible intestinal coils as well as local swellings not thus characterized. The latter were either palpable or their limits were determined by dullness on percussion in an elsewhere resonant and unusually distended abdomen. Such tumors and visible coils occurred as follows in the cases of strangulation :—

	Tumors.	Visible Coils.
Adhesions	4	7
Vitelline remains	4	3
Appendix	1	1
Slits	1	--
	10	11

Thus in less than one-fifth of the cases tumors were to be recognized. The numbers are not sufficient to serve any purpose of differential diagnosis.

Fever was noted in 22% of all the cases. It rarely occurred before the second day, was sometimes absent altogether, and, when present, the temperature was below 100° F. in nearly one-half of the cases. Its occurrence and intensity were of no positive value in the diagnosis of obstruction from strangulation.

Hiccough was a symptom of such infrequent record as not to demand any especial attention.

As a rule no mention was made of any peculiarities of the urine or its flow. The latter was sometimes mentioned as scanty during the first few days and after the tenth day, while it was often stated as normal on the thirteenth day. Its composition was usually noted as normal ; occasionally it was reported to contain albumen or indican. The cases furnished no evidence that any alteration of the quantity or quality of the urine is of any diagnostic value.

In like manner with regard to collapse. The date of its occurrence was given in 23% of the cases, but the figures are too few to aid much in fixing upon the time when all efforts at purely medical treatment shall cease.

Date.	Adhesions.	Vit. remains.	Appendix.	Pouches, etc.	Total.
1st day	1	--	--	--	1
2nd "	2	--	--	--	2
3rd "	2	1	1	--	4
4th "	--	1	--	--	1
5th "	2	1	1	--	4
6th "	1	1	--	--	2
7th "	1	1	--	--	2
9th "	1	2	--	--	3
10th "	--	1	--	--	1
11th "	1	--	--	1	2
13th "	1	--	--	--	1
	12	8	2	1	23

The occurrence of collapse is not to be regarded as necessarily indicative of a fatal termination, as in several cases recovery followed laparotomy, where collapse was noted at or before the time of operating.

The bowel obstructed was recorded as follows in 74% of the cases :—

Intestine Obstructed.	Adhesions.	Vit. remains.	Appendix.	Slits.	Pouches, etc.	Total.
Small	39	15	6	4	2	66
Large	5	--	--	2	1	8
	44	15	6	6	3	74

The part of the intestine obstructed in strangulation, as determined in fully three-fourths of all the cases, is the small intestine in nearly 90% of the cases, and the large in 10%.

The region of the abdomen in which the strangulating object was found was as follows in 72% of the cases:—

	Adhesion.	Vit. remains.	Appendix.	Slits.	Pouches, etc.	Total.
Right iliac fossa	19	21	6	1	1	48
Pelvis	7	--	--	--	1	8
Left iliac fossa	5	--	--	1	--	6
Left lumbar region	3	--	--	--	--	3
Right lumbar region	2	--	--	--	--	2
Umbilical region	2	--	--	--	--	2
Right hypochondrium	1	--	--	--	1	2
Left hypochondrium	1	--	--	--	--	1
	40	21	6	2	3	72

The position of the strangulating object was thus in the right iliac fossa in 67%, and in the lower abdomen in 83% of the cases in which its position was given. It was present in the lumbar and umbilical regions in 10%, and in the upper abdomen in 7%.

It is obvious that an absolutely exact diagnosis of obstruction from strangulation is only to be made by a post-mortem examination or a laparotomy. From this point of view the mortality is total unless operative interference has been tried with success. Of one hundred and one cases, seventy-five died and twenty-six recovered.

The following tables were prepared to show the date of death in the absence of surgical treatment, and the relation of deaths to recoveries after surgical interference.

Date of death in thirty cases of strangulation under purely medical treatment:—

Date.	Adhesions.	Vit. remains.	Appendix.	Slits.	Pouches, etc.	Total.
2nd day	4	1	1	1	--	7
3rd "	3	1	--	1	--	5
4th "	2	1	--	--	1	4
5th "	1	--	--	--	--	1
6th "	1	1	--	1	--	3
8th "	2	--	--	--	--	2
9th "	--	2	--	--	--	2
10th "	1	--	--	--	--	1
11th "	2	--	--	--	1	3
18th "	--	--	--	1	--	1
37th "	--	1	--	--	--	1
	16	7	1	4	2	30

It is evident that death occurred from the second to the fourth days, inclusive, in more than one-half of the cases where no surgical treatment was applied.

Operative interference took place in 67% of the cases, and with the following results:—

Date.	Adhesions.	Vit. remains.	Appendix.	Slits.	Pouch, etc.	Tumor.	Total.	Death.	Recovery.
1st day	1	--	--	--	--	--	1	1	--
2nd "	1	1	--	--	--	--	2	1	1
3rd "	2	--	1	--	--	--	3	3	--
4th "	2	1	--	1	--	--	4	4	--
5th "	5	2	2	1	--	1	11	5	6
6th "	6	1	1	--	--	--	8	3	5
7th "	8	--	--	--	--	--	8	6	2
8th "	2	1	--	--	--	--	3	1	2
9th "	3	1	--	--	--	--	4	3	1
10th "	2	1	--	--	--	--	3	1	2
11th "	2	2	--	--	1	--	5	5	--
12th "	2	--	--	--	--	--	2	2	--
13th "	2	--	--	--	--	--	2	1	1
14th "	--	1	--	--	--	--	1	1	--
16th "	--	1	--	--	--	--	1	--	1
25th "	1	--	--	--	--	--	1	--	1
Not given	6	1	1	--	--	--	8	4	4
	45	13	5	2	1	1	67	41	26

The percentage of recoveries after surgical interference in cases of strangulation was 39%.

INTUSSUSCEPTION.

Of all the varieties of acute, internal, intestinal obstruction that which most often presents the clearest clinical picture is intussusception or invagination.

Its relative frequency among the more important causes is nearly constant at 39 %, and ninety-three cases are included in the series collected since 1880. None were recognized as such unless the diagnosis was substantiated at an autopsy, by laparotomy, rectal examination, or by the discharge of a slough.

It occurred among males in fifty-two cases, among females in twenty-seven; about two-thirds of the cases were thus found in the former sex and one-third in the latter. The relative frequency at various periods of life is shown below :

Year of age.	Number of cases.	Per cent.
Under 1	31	34
From 1—2	5	
2—3	3	
3—4	1	
4—5	3	
5—6	4	
6—7	1	
7—8	1	
8—9	2	
Under 10	51	56
From 10—20	6	
20—30	13	
30—40	9	
40—50	5	
50—60	2	
60—70	4	
70—80	1	
	91	

Exciting causes were absent in forty-two cases, 45 %; and the following were possible causes in fifty-one cases, 55 %:

Diarrhœa	in 13	cases.
Habitual constipation	" 12	"
Protracted abdominal pain	" 7	"
Indigestible food	" 6	"
Violent exertion	" 4	"
Injury	" 3	"
	45	"

Single cases occurred in the course of typhoid fever, gastro-enteritis, variola, pregnancy, after an operation for incarcerated hernia, and after the use of cathartics,—in all, six cases. A preceding like attack was observed in two instances.

These possible factors are of but little value in differential diagnosis; and their frequency without injurious sequences makes their further consideration of little or no importance.

Our knowledge of the method of production of the invagination has been rendered relatively exact by the experiments of Nothnagel * and of Senn.† The former found that a contracted bit of intestine pushed itself into a passive portion from above downwards. This contraction was induced ‡ by a faradic current, and in the course of a minute or two the invagination might become four inches long. He found that the internal and external cylinders were formed below the tetanized part, almost without exception. If the intestines were paralyzed by crushing no invagination occurred. These observations go to show that the invagination is always descending and is rather spasmodic than paralytic. Senn also found that the invagination was early formed in a relaxed bowel and could not be produced in the contracted gut.

The most important symptoms of intussusception are abdominal pain, nausea or vomiting, tympany, tumor, bloody stools, and tenesmus.

Their relative frequency was reported as follows:

Pain	in 65 cases	= 70	per cent.
Nausea or vomit	" 66 "	= 71	"
Tympany	" 31 "	= 33	"
Tumor	" 64 "	= 69	"
Bloody stools	" 56 "	= 60	"
Tenesmus	" 33 "	= 35	"

The date of the appearance of these principal symptoms of intussusception is represented in the following table :

Date.	Pain.	Nausea or Vomit.	Tympany.	Tumor.		Bloody Stools.	Tenesmus.
				Abdomen.	Rectum.		
1st day	61	51	1	9	10	32	15
2nd "	2	4	2	12	8	7	4
3rd "	1	3	8	8	7	6	5
4th "	1	3	8	2	3	3	--
5th "	--	1	4	--	2	1	2
6th "	--	--	3	3	4	3	3
Later or not given	--	4	5	5	6	4	4
Total no. of cases	65	66	31	39	40	56	33

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* Nothnagel. Zeitsch. f. klin. Med., 1882, iv. 555.

† Senn. Annals of Surgery, 1888, vii. 4.

‡ Nothnagel. Wien. Med. Bl., 1883, v. 1433.

Where pain was recorded as a symptom, it appeared on the first day in nearly all the cases. Its early absence, on the contrary, was conspicuous in rare instances. It was usually described as abdominal, and was sometimes located at the navel, in the stomach and epigastrium, and in the right iliac fossa.

It was referred to the left iliac fossa in rectal or colico-rectal varieties of intussusception. Of five cases in which the pain was said to be at the navel, the intussusception was of the ileum in three instances. The seat of the pain in the right iliac fossa frequently led to the diagnosis of typhlitis, perityphlitis, or typhoid enteritis.

It was usually sudden, severe, perhaps violent, and was frequently spasmodic. In one case it was so intense as to lead to an attempt at suicide. Its importance in the diagnosis of the seat of the intussusception was merely relative. The possibility is obvious that its seat in either iliac fossa might serve to differentiate an intussusception of the colon or rectum from one near the cæcum. In like manner its position at the navel might serve to suggest the small intestine as the seat.

Nausea or vomiting occurred on the first day in nearly nine-tenths of the cases in which a definite date could be fixed. If nausea occurred in the first instance it was rapidly followed by vomiting. The latter presented no characteristics of any value in differentiating this variety of intestinal obstruction, except in the rarity of its becoming fecal. Among the ninety-three cases of intussusception fecal vomit is noted in only twelve patients, and it appeared on or after the fourth day in all but two of these. In nearly one-third of the twelve cases, the obstruction was fixed at or below the cæcum. In two-thirds the intussussception was of the small intestine; in at least one-half of these certainly away from the valve, in the other half possibly near the valve. This symptom, therefore, has no absolute value in determining the existence of an intussusception; if the latter is rendered probable, fecal vomit suggests that the seat is at or above the cæcum.

Tympany is perhaps the least important symptom of obstruction by intussusception. It occurred only in one-third of the cases, and in one-half of these on the third and fourth days.

A tumor was found in sixty-one cases, nearly two-thirds of the entire number. It was found in the abdomen only in twenty-three cases, in the rectum only in twenty-one, and in the abdomen and rectum in sixty-one. It is stated to have been absent in four instances, while in twenty-eight its presence is not mentioned. It was found on the first day in more than one-third of the cases, on the second day in one-fourth, and on the third day in more than one-fifth of the cases. Thus in more than one-half of all it was present in the first two days, and in the first three days in more than three-fourths of the cases. The relative frequency of its presence in the abdomen or rectum on these days is shown in the preceding table. In the cases of intussusception of the small intestine a tumor was not observed. The general characteristics of the tumor of intussusception are sufficiently well known. It was often associated with a relaxed sphincter.

The rectal discharges in intussusception are of the greatest importance in diagnosis, especially as they not infrequently continue throughout the disease. Diarrhœa may immediately precede the attack, and the alvine discharges may be wholly fecal at the outset, but rapidly become mixed with blood. Pure blood or blood and mucus are the more frequent discharges. They may occur spontaneously, or immediately follow a rectal examination, or the use of an enema.

Bloody stools were recorded in three-fifths of the cases; and occurred the first day in the same proportion of cases where a definite date was given.

Tenesmus was stated to be present in nearly one-third of the cases, in about the same number as was tympany. Its presence on the first day was noted in one half of these, when a fixed date was mentioned.

Fever occurred in twenty-six cases, 28 % of the entire number. Its absence in five was conspicuously stated, while no mention was made in sixty-two instances. The temperature was elevated on the first day in four cases, on the second in seven, on the third in eight, on the fourth in four, and in one on each of the three succeeding days.

Intussusceptions are classified anatomically according to the part of the bowel affected. They are, without more minute subdivision, of the small intestine into itself, into the cæcum, or into the colon, of the colon into itself or rectum, and of the rectum into itself. The relative frequency of these varieties has a decided practical importance; and of sixty-five cases the variety was as follows:

Ileo-cæcal or ileo-colic	48 cases	= 75	per cent.
Enteric	8 "	= 12	"
Rectal	5 "	= 8	"
Colico-rectal	4 "	= 5	"
	65	100	

The intussusceptions in the vicinity of the cæcum thus represented three-fourths of the whole number. The question as to the variety in any given case will lie essentially between this form and that of the small intestine away from the valve, which occurred in only one-eighth of the cases. The rectal and colico-rectal varieties are usually easily recognized on rectal examination.

These figures differ considerably from those of Leichtenstern,* based upon a collection of four hundred and seventy-nine cases, which are as follows: Ileo-cæcal and ileo-colic, 52 %; ileal (enteric), 30 %; rectal and colico-rectal, 18 %. The chief difference lies in the greater frequency of the varieties originating near the cæcum in the smaller series and in the lesser frequency of the enteric variety. It is possible that the latter difference may result from the more critical exclusion of post-mortem cases. The former difference may be due to the inclusion, for practical purposes, of ileal intussusception near the valve among ileo-cæcal forms.

The mortality in cases of indisputable intussusception was very great, excepting in the rectal variety. The following table shows the number and date of deaths of other varieties than the rectal, when the treatment was by other measures than surgical:

Date.	Deaths.
1st day	2
2nd "	2
3rd "	6
4th "	3
5th "	5
6th "	1
1st week	19
2nd "	6
3rd "	1
Not given	9
	35
Recoveries	16
	51

It thus appears that of the above series 69 % died and 31 % recovered. Of the fatal cases nearly one-half, and perhaps a larger proportion, died during the first five days. The third, fourth, and fifth days were especially fatal.

The following table shows the mortality after surgical interference:

Date of operation.	No. of cases.	Deaths.	Recovery.
1st day	1	1	0
2nd "	1	0	1
3rd "	6	5	1
4th "	4	4	0
5th "	4	2	2
6th "	4	3	1
7th "	2	2	0
8th "	4	4	0
9th "	3	3	0
Not given	7	6	1
	36	30	6

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* *Op. cit.*, 501.

The mortality after surgical treatment was thus 80 %, against 69 % following medical treatment.

TWISTS AND KNOTS.

Acute obstruction from volvulus or twist occurred in forty cases, and from knots in two instances. As already stated, the symptoms from knots are essentially the same as those from strangulation. Their occurrence is so rare that they may practically be disregarded.

Of the forty cases of volvulus since 1880, the vast majority were axial, but in rare cases a part of the small intestine was twisted about another portion. As but two instances of the latter variety occurred in the series these have been included among the former, although their symptoms are those of cords and bands, while their prognosis is, perhaps, more favorable. Their number is such as not to materially modify the conclusions to be drawn.

Of thirty-eight cases of volvulus twenty-six occurred in males and twelve in females ; 68 % in the former and 32 % in the latter.

The ages of the patients was as follows in thirty-four cases :

Year of age.	Number of cases.
6	1
From 15—20	4
20—25	2
25—30	2
30—35	6
35—40	6
40—45	3
45—50	2
50—55	1
55—60	5
65—70	1
70—73	1
	34

The extremes of life represented are therefore six years and seventy-three years. The greatest number of cases in any ten years was between the ages of thirty and forty, and was about one-third of all.

In the etiology of this class of cases of obstruction, the previous occurrence of a similar attack was observed in five instances. A constipated habit was noted in six cases. Hernias existed in three. Two of the patients were insane, and one was paralytic. One suffered from chronic diarrhœa. Upon another the operation of ovariotomy was performed six years before the obstruction took place. In four cases violent exercise was the exciting cause ; in another an attack of diarrhœa; and in still another irritating food.

The following table shows the relative frequency of the principal symptoms of volvulus:

Date.	Pain.	Nausea or vomiting.	Tympany.
1st day	19	9	1
2nd "	--	2	1
3rd "	--	--	3
4th "	2	2	3
5th "	--	--	1
6th "	--	1	1
7th "	--	--	2
Later or not given	3	1	10
Total no. of cases	24	15	22

Abdominal pain was thus the first symptom of importance in nearly one-half of all the cases, and it occurred on the first day in nearly all where the date was recorded. It was sudden in one-half of the above number. It was either severe, intense, extreme or violent in as many cases, and in only one instance was there a record of no particular pain. It was seated near the navel in four cases, in the left abdomen and in the left iliac fossa each in two instances; in the lower abdomen, left groin, right iliac fossa, and near the stomach each in one case.

It was found, therefore, most often, in one-fifth of the cases, on the left side, then at the navel in one-sixth of the cases, and elsewhere in the abdomen in small but equal proportion.

The pain was stated to be associated with nausea or vomiting in three-fifths of the cases where a date was given. In two cases there was no vomit as late as the eighth day, in one till the eleventh day, and in another there was none at all.

The vomit was fecal in six cases,—in three on the fourth day, in one on the sixth day, in one on the eleventh day, and in another no mention is made of the date of its occurrence. It was slight in two of the cases. It occurred in four instances where the small intestine was obstructed, and in two where the large intestine was twisted. On the contrary, in three cases where the volvulus was of the small intestine, there was no fecal vomit.

Although tympany was recorded in more than one-half of the cases, it was present during the first week in only about one-half of these. Its occurrence during the first week was oftenest on the third and fourth days. It might be much on the first day, or slight on the fourth day. It was described as enormous on the ninth day.

Tumors are not a characteristic of twist, but the abdominal swelling might be so circumscribed as to suggest a tumor. When the flanks alone were swollen the twist was of the large intestine; when the umbilical region was conically distended the obstruction was either of the large or of the small bowel. Visible coils were present only in three cases. In one the coil was the transverse colon, the twist being of the sigmoid flexure. In a second the sigmoid flexure was also twisted. In the third the volvulus was probably of the small intestine.

A record of the temperature was made in sixteen cases. In four there was no elevation on the third, sixth, and seventh days. In two the temperature was fairly normal or slightly elevated. Of the cases of distinct elevation, there were three in which the temperature on the fourth day was between 99·6° F. and 101·3° F. The temperature is first recorded as elevated on the second, third, fifth, sixth, ninth, and tenth days, each in one case. Since in only about one-fourth of the cases was there any noteworthy elevation of temperature, and since in two-thirds of these cases it took place on no particular day between the second and tenth days, it is obvious that fever is no important characteristic of obstruction from a twist.

Hiccough was present in three cases, apparently without especial dependence on the part of the intestine twisted.

Occasional records were made of the condition of the urine. It was rarely reported as modified in quantity or quality. In one case only half a pint was passed on the seventh day. In another four ounces were passed in twelve hours on the ninth day. There was retention on the fourth day in a single case. In another patient an increased quantity of indican was reported on the eighth day. In all the other cases there was either no record of its condition or the flow was reported as free or as abundant.

The seat of the twist is shown in the following table.

Seat.	Number of cases.	Per cent.
Sigmoid flexure	19	49
Ileo-cæcal region in 6 Cæcum in 5	11	29
Small intestine	5	13
Ascending colon	2	5
Colon	1	2
Descending colon	1	2
	39	100

It is thus evident that about one-half of the cases of twist took place at the sigmoid flexure, and that nearly one-third of them were present in the ileo-cæcal region. It is further evident that, for all practical purposes, 87% of the cases occurred in the large intestine.

An absolute diagnosis of volvulus is only to be made by abdominal section, either before or after death. Death is, therefore, to be regarded as the probable result of this lesion unless the surgeon affords relief. This statement is made despite the fact that in five of the cases there was the previous history of a similar attack.

Death occurred as follows in cases not treated surgically:—

1st day	1
3rd "	2
5th "	2
7th "	3
8th "	2
9th "	1
12th "	1
Not given	3
	15

The date and result of operative interference is given in the following table:—

Date of operation.	Number of cases.	Death.	Recovery.
3rd day	2	1	1
4th "	1	1	0
5th "	3	2	1
6th "	2	2	0
7th "	1	1	0
9th "	6	5	1
10th "	1	1	0
11th "	1	1	0
16th "	1	0	1
26th "	1	0	1
Not given	6	6	0
	25	20	5

It is apparent from the above tables that all of the cases not treated surgically died, and that of those thus treated one-fifth recovered.

Since, of known dates of death, at least one-half took place before the eighth day, it is obvious that medical treatment should cease before this date. Furthermore, since, of the cases treated by the surgeon from the third to the sixth day only one-third recovered, it is suggested that medical treatment should cease at the former date.

OBSTRUCTION BY ABNORMAL CONTENTS.

Acute obstruction of the intestines by abnormal contents, as biliary and intestinal calculi, more or less inspissated fæces and foreign bodies, form a series, where plugging of the bowel is the immediate cause of the disturbance.

Foreign bodies introduced into the mouth and rectum, and there causing symptoms of acute obstruction, are so immediately recognized and their treatment so apparent, that they require no consideration in the present communication. If taken into the mouth they usually offer no difficulty of diagnosis, if intestinal obstruction is to follow. The etiology is usually clear ; the symptoms, as shown in the three cases of this sort occurring during the past eight years, are so mild, that the chief, if not the sole, evidence of obstruction was the absence of a stool for three days in two instances, and for twelve days in a third. Pain and nausea or vomiting were absent, except in an infant of twelve months, who had swallowed wool-fibres. There was no tympany. A soft tumor near the cæcum, on the fourth day of absent stools, was found in one case, and was probably composed of lumbrici. There were no associated symptoms to suggest a more serious cause of tumor in the cæcal region.

There were two cases of intestinal calculi which offered grave symptoms of obstruction. The calculus in one case was composed of shellac, in the other of date seeds and gritty material.

The number of cases of obstruction from abnormal contents is thus reduced to twenty-three of biliary calculi, nineteen of fæces, and two of enteroliths, making forty-four in all.

This number may seem small, but in a critical consideration of reported cases, it is necessary to exclude many as doubtful. This is especially true with regard to gall-stones and fæcal masses. If the patient dies, and a gall-stone obstructs the bowel, the evidence furnished is rarely sufficient to exclude the possibility of the obstructive symptoms resulting from a peritonitis. The latter, occasioned, not by the presence of the calculus in the bowel, but by the destructive processes associated with its entrance into the gut. Medical treatment in this class of cases may often prove efficient, since the symptoms of obstruction may be due to the peritonitis and not to the plugging.

Similar statements hold true with regard to reported cases of obstruction from fæces. If fæcal tumors are found, and symptoms of intestinal obstruction are present, it by no means follows that the symptoms are immediately due to the fæces. An associated peritonitis from an inflamed appendix is of so frequent occurrence, and alone suffices to suggest the diagnosis of obstruction. With the presence of a fæcal tumor the diagnosis seems to be substantiated. The analysis which is to follow will show, however, that enormous fæcal accumulations may exist, and very few symptoms arise to suggest an attack of acute, internal obstruction.

The sex of the cases of obstruction from abnormal contents, is as follows:—

	Gall-stones.	Fæces.	Enteroliths.	Total.
Males	5	8	2	15
Females	18	11	0	29
	23	19	2	44

Obstruction from gall-stones thus occurred among females in two-thirds of the cases; while in obstruction from fæces the question of sex is not important.

The age at which the obstruction occurred is seen in the following table:—

Year of Age.	Gall-stones.	Fæces.	Enteroliths.	Total.
At 8	--	1	--	1
From 10—20	--	4	--	4
20—40	--	4	--	4
40—45	1	0	--	1
45—50	3	0	--	3
50—55	3	2	1	6
55—60	6	2	--	8
60—65	3	4	--	7
65—70	3	1	--	4
70—75	2	--	--	2
75—80	1	1	--	2
	22	19	1	42

It is thus apparent that obstruction from gall-stones occurred only in adults, and after the age of fifty years, in six-sevenths of the cases; that obstruction from fæces may occur at any time of life; while enteroliths were found in adult life.

In eleven cases, nearly one-half, of obstruction from gall-stones there was a previous attack attributed to biliary calculi. In the nineteen cases of fæcal obstruction, habitual constipation, often no dejection for several weeks, was almost invariably present.

The shellac-calculus was present in a cabinet-maker who was accustomed to drink an alcoholic solution of shellac. In the cases of fæcal obstruction loose dejections were occasionally noticed, although the bowels contained large quantities of fæces.

The accompanying table shows the date and relative frequency of the important symptoms of obstruction from gall-stones:—

Date.	Pain.	Nausea or Vomit.	Fecal Vomit.	Tympany.
1st day	13	10	--	1
2nd "	--	2	1	1
3rd "	--	1	3	1
4th "	--	1	1	2
5th "	--	--	2	3
Later or not given	6	3	7	5
	19	17	14	13

Abdominal pain was the initial symptom of the attack of obstruction in two-thirds of the cases. It was usually sudden, severe, or intense, sometimes described as griping. It was exactly localized on the first day in but two cases. In one the seat was referred to the epigastrium, in the other to the hypogastrium. After the first day the pain was referred to the epigastrium in four cases, to the navel in two, to the hypogastrium in two and to the right iliac fossa in one.

Nausea or vomiting was present on the first day in about three-fifths of the cases. The vomit was inky in one case on the third day, and bloody in another on the fourth day. It was slight in two cases. Fæcal vomit was present in nearly two-thirds of the cases of obstructing gall-stones, and, as near as could be ascertained, most frequently on the third day.

Tympany was present nearly as often as fæcal vomiting. It was usually slight or not excessive, and was repeatedly stated to have been absent.

A tumor was rarely noticed. Once in the right iliac fossa, and proved to be the calculus. Twice at the navel on the third day. It is stated to have been as large as a child's head in one of these cases. The tumor was present in the left inguinal region in one case, and once was found on rectal examination.

The temperature was as high as 101° F. in one case and between 99° F. and 100° F. in three cases on the fourth and fifth days. In the majority of cases it was either normal or subnormal.

Jaundice and hiccough were symptoms in but two cases of gall-stones, and occurred early. The urine was diminished in quantity in five instances, being noted as scanty on the second, fourth and fifth days, and as absent on the sixth day. Once it contained cholesterine discharged from the rectum.

Of the twenty-three cases of obstruction from gall-stones there were thirteen deaths and ten recoveries. Twelve cases were treated medically and eleven surgically; of the former, eight recovered and four died; of these latter, one on the fifth, seventh and tenth days, respectively, and one on a date not given.

In the cases of recovery the calculi were passed on the fourth, fifth (in two cases), tenth, fourteenth, fifteenth, seventeenth, and twentieth days.

Surgical interference took place as follows:

Date.	Number of cases.	Recovery.	Death and date.	
3rd day	1	0	1	8th day.
4th “	1	0	1	4th “
5th “	1	0	1	5th “
7th “	2	1	1	7th “
8th “	2	0	2	8th “ 9th “
9th “	1	0	1	14th “
17th “	1	0	1	18th “
Not given	2	1	1	Not given.
	11	2	9	

The seat of the calculus in the fatal cases was the ileo-cæcal region in four, the jejunum in three, the ileum in three, the small intestine in two, and the duodenum in one case.

Since all the operative measures after the seventh day terminated fatally, and five cases recovered after this date under medical treatment alone, the condition of the patient must determine the treatment to be followed.

In fæcal obstruction pain at the outset was rare. It was present in six cases only, one-third of the whole number, and was absent on the fifth day in one instance, on the fifteenth in two, and on the twentieth in one. It was seated in the right iliac fossa, in the region of the stomach and liver, and in the left iliac fossa each in one case.

Nausea or vomiting was present in nine cases and absent in ten. It was of late occurrence, the date being stated in only three cases, in these on the fifth, fourteenth, and nineteenth days. It was fæcal in but three cases and in these the only date assigned was the twentieth day.

Tympany was present in rather more than a third of the cases, and usually at a late date, after the first week. The abdomen of a child measured thirty-one inches, of an adult forty-three inches in circumference.

An abdominal tumor was noted in about one-half of the cases of obstruction from fæces. It occupied the entire abdomen in three instances, was situated in the left lumbar region in two, in the left hypochondrium, the left iliac fossa, the right side and right iliac fossa each in one case. The tumor was described as elongated, rounded, nodular, slightly movable, hard, dull. Scybala were occasionally to be felt in the rectum.

The temperature was rarely above the normal. The urine was scanty on the fifteenth and twentieth days in two cases of fæcal obstruction.

The seat of the obstruction was the large intestine, and its lower part was more often involved than the upper. This evidence is in favor of the view that the fæcal tumor in so-called stercoral typhlitis is rather the result of an inflamed appendix than the cause of an inflamed cæcum.

There were fifteen recoveries and four deaths among these cases. In one the death was due to perforation of the bowels, in another it was attributed to pulmonary congestion, and in two there was no obvious anatomical cause.

In the cases which recovered the obstruction lasted from two to three weeks in three cases, from three to four, four to five, five to six weeks, one in each period, and in one case it lasted for four months.

The medical treatment consisted of large enemata, irrigations, electricity, and various purgatives. Laparotomy, colotomy, and division of the anus were each performed in one instance.

It is obvious from the above consideration that obstruction from fæces may be excluded from the series of acute, internal, mechanical obstructions, because abdominal pain, tympany, and fæcal vomit were rare and late, while nausea or vomiting was also of late occurrence. A tumor was present in half the cases, and was characteristically fæcal.

Fever was absent. Furthermore, rectal injections are likely, at once, to give positive evidence of fæcal obstruction.

The rarity of obstructing intestinal calculi was such that they may practically be disregarded. If present, their significance is that of gall-stones.

STRICTURES AND TUMORS.

Malignant disease and strictures of the intestine, and abdominal tumors outside the intestine, are sometimes the cause of symptoms of acute obstruction, and the former may require consideration in differential diagnosis.

There have been fifteen cases of such strictures and tumors of the intestine since 1880, of which ten occurred among females and five among males.

The age of these patients was as follows:—

Years of Age.	Number of cases.
From 20—30	2
30—40	1
40—50	3
50—60	4
60—70	5
	15

Four-fifths of the cases thus occurred after the age of forty, and three-fifths after the age of fifty years.

In two-thirds of the patients antecedent symptoms of abdominal disturbance were present as follows:—

Chronic abdominal pain	in 3 cases.
Constipation	" 3 "
Irregular and bloody discharges	" 1 case.
Rectal uneasiness	" 1 "
Previous attacks	" 1 "
Hernia	" 1 "
	10

The date and relative frequency of the important symptoms of intestinal obstruction from strictures and tumors is shown in the following statement:—

Date.	Pain.	Nausea or Vomit.	Tympany.	Tumor.
1st day	8	4	--	--
2nd “	1	1	--	--
3rd “	--	2	1	--
4th “	--	1	1	--
5th “	--	1	1	--
6th “	--	--	3	--
Later or not given	--	3	4	4
	9	12	10	4

Although pain was the first symptom in one half of the cases, in two the attacks began with constipation. The pain was seated in the lower abdomen in three instances.

The vomit became fæcal in five cases; the earliest date was the third day. The tympany might be enormous on the third day, or moderate on the sixth day.

A tumor was perceptible by rectal examination in two cases, and by palpation in the iliac fossæ each in one case. In three instances there were visible intestinal coils.

The temperature was not elevated before the sixth day, was never higher than 102·2° F., and then not till the tenth day.

The lesion and its seat were as follows:—

Cancer of the sigmoid flexure	in 5 cases.
“ “ rectum	“ 3 “
“ “ colon	“ 2 “
“ “ cæcum	“ 1 case.
Stricture of the ileum	“ 1 “
“ “ cæcum	“ 1 “
“ “ colon	“ 1 “
“ “ rectum	“ 1 “
	15

The obstruction was thus of the large intestine in fourteen cases, and of the small intestine in but one instance. It was situated in the left iliac fossa or pelvis in nine cases, nearly two-thirds of the whole number, and in the right iliac fossa in two cases. The seat was thus in the lower abdomen in nearly four-fifths of all the cases of acute obstruction from strictures and tumors.

Of the fifteen cases eleven died and four recovered from the immediate symptoms of obstruction. The nature of the lesions is such that surgical treatment alone offers hope. In eight cases where death occurred without surgical treatment, it took place on the fourth, fifth, eighth, twelfth, eighteenth, and fifty-fourth days each in one case, and on the seventeenth in two cases.

Surgical treatment was employed in seven cases, with the following immediate result:—

Date of operation.	Number of cases.	Recovery.	Date of death.
5th day	1	1	0
7th "	1	1	0
8th "	1	0	1, after 9 weeks.
9th "	2	2	0
14th "	1	0	1, 17th day.
Not given	1	0	1, same day.
	7	4	3

As the result of the foregoing analysis the symptoms, apart from stoppage of the bowels, upon the presence of which the physician must rely to establish a diagnosis of acute, internal obstruction, are abdominal pain, nausea or vomiting, abdominal tympany, and abdominal tumor. The presence of fever, the occurrence of hiccough or jaundice, abnormal conditions of the urine, are all occasional and subordinate.

The cardinal symptoms are, then, pain, vomiting, tympany, and tumor. The vomit may become fecal, and the tumor may be simulated by visible intestinal coils. The relative frequency, in percentages, of the occurrence of these symptoms in the main varieties of acute, intestinal obstruction, as occurring since 1880, is here shown:—

	Strangulation.	Intussusception.	Twist.	Gall-Stones.	Stricture or Tumor.
Pain	82	70	60	83	60
Nausea or Vomiting	69	75	37	74	80
Fecal Vomiting	47	13	15	61	33
Tympany	56	33	55	56	66
Tumor	10	69	--	13	27
Visible coils	11	--	7	--	20

But the presence of these cardinal symptoms is evidence of other disease than acute, internal, mechanical obstruction of the bowels. They may result from external causes of obstruction, and the various herniæ are to be excluded. They may be the symptoms of peritonitis in the absence of mechanical, intestinal obstruction. The various causes of peritonitis are therefore to be excluded. These include those arising from the gastro-intestinal, genital, and urinary tracts, the biliary passages, suppurating or necrotic lymph-glands, embolism of the abdominal arteries, and from the continuance of inflammatory processes through the thoracic and abdominal walls.

The diagnosis of acute, internal obstruction is then made, in the first instance, by exclusion.

The second question relates to the part of the bowel which is the seat of the obstruction. It appears from the above analysis that the chief varieties of obstruction were situated as follows:—

	Large Intestine.	Small Intestine.
Strangulation	8	66
Intussusception	57	8
Twist	34	5
Gall-stone	4	9
Stricture and tumor	14	1
	117 = 57 per cent.	89 = 43 per cent.

It is obvious that obstructing gall-stones in the large intestine are not of much consequence from their seat in that part of the bowel, as they have usually produced their important symptoms before reaching the colon.

The obstruction, therefore, is likely to be either in the small or in the large bowel in not far from equal proportion. In order to determine which is affected, the patency and capacity of the large intestine must be ascertained as thoroughly as possible.

Rectal examination by the finger alone may make the diagnosis clear, as in certain cases of intussusception, stricture, and obstruction from abnormal contents. The limits of this method, however, are easily reached. Exploration by the introduction of the entire hand into the rectum may then suggest itself as a means of determining the seat of the obstruction. The cases are but a few where such a method has been used in intestinal obstruction with success. They are so few and the evidence thus to be obtained is so indefinite, that this method of exploration may be placed among the possibilities in any given case, but as of doubtful expediency.

There remains the introduction of the rectal sound or tube. These have the advantage in length over the finger or hand; they have the disadvantage of giving rise to errors of judgment. The information to be furnished by the rectal sound is limited to the determination of the length and calibre of the rectum and sigmoid flexure, at the most as far as the junction of the two legs of the bowel which form the loop. This may lie at the navel, as in a case recently examined by me after death. It has been my experience to fail to pass either the rigid or the flexible tube beyond the sigmoid flexure in numerous attempts both on the living and dead. After repeatedly introducing the flexible tube its entire length, it has been found compactly coiled within the rectum on passing the finger through the anus. In these respects my experience corresponds with that of Treves* and others.

The use of the rigid tube is not without danger. I have known it, in the hand of a skillful and experienced surgeon, to perforate the intestinal wall above a stricture of the rectum.

The capacity of the large intestine, beyond the reach of the finger, or a short tube, is best determined by an attempt to distend the bowel with air, gas, or water, under a certain degree of pressure. Air may be introduced by connecting the end of an inserted rectal tube with the nozzle of a syringe or a pair of bellows.

Air or gas may be allowed to escape from a siphon of aerated or carbonated water. Ziemssen† recommends that the intestine be charged, alternately and in small quantities, with solutions of bicarbonate of soda and tartaric acid,—twenty grammes (five drachms) of the former and eighteen grammes (four and a half drachms) of the latter.

The simplest and best agent, however, is warm water. It is easily procured, and the quantity used can be simply and accurately measured.

Some arrangement is necessary by means which the injected fluid shall be prevented from escaping from the anus. Forcible compression of the buttocks against the rectal tube suffices for moderate degrees of pressure. But the column of fluid may be under considerable, even extreme, pressure, especially when this diagnostic procedure becomes a remedial measure, as in cases of intussuspection.

Lund‡ figures and describes an apparatus for this purpose, consisting essentially of an annular air-cushion through which passes a tightly fitting rectal tube. The latter is connected with the injecting syringe. A similar apparatus was improvised by Forest,§ who wound a roller bandage tightly around a glass, vaginal syringe, from which the piston was removed. The mouth of the syringe was closed with a perforated cork. A glass tube was pushed through this and was connected with the injecting syringe. This latter is most conveniently a fountain-syringe or a funnel and a rubber tube. These may be elevated gradually to any desired height above the patient's level, and will permit an accurate measure of the pressure used and the quantity injected.

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* Treves, *op. cit.*, 398.

† Ziemssen, Arch. f. klin Med., 1883, xxxiii, 236.

‡ Lund. Lancet, 1883, i. 588.

§ Forest. Am. J. Obst., 1886, xix. 673.

The force necessary to distend the large intestine sufficiently to determine its calibre may be slight. But the physician should be prepared to increase it sufficiently, within safe limits, to make it clear that the large intestine is or is not obstructed. These limits are determined by the time which has elapsed since the obstruction became apparent, the age of the patient, and the quantity of fluid injected.

Thomas* records a case where, on the third day, an enema, under light pressure, was followed by death in an hour and a half. The case proved to be one of intussusception ; a rent was found in the sheath and a half tumblerful of water in the pelvis. The earlier, therefore, this method of exploration is employed the better, especially in the case of suspected intussusception.

The age of the patient is important, since obstruction in children is most likely to be from intussusception. Lower degrees of pressure will produce rupture in them than in the adult, and the capacity of the large intestine is less.

The quantity of fluid admitted is as important as the force necessary for its injection. For diagnostic purposes all that is necessary is that a certain quantity of fluid should or should not be admitted into the bowel. The quantity which the large intestine of the adult will hold with safety may be stated at six quarts. In a case of catarrhal enteritis recently under my charge, nearly five quarts were gradually injected without discomfort by means of a bulb-syringe and rectal tube. Six quarts of fluid returned through the tube after removal of the syringe. Larrabee† states that six quarts were injected into the intestine, and retained, in a case of obstruction of the ileum. The quantity which the large intestine of the infant may safely receive has been less exactly determined than the degree of pressure which can be applied without causing rupture.

The limits of safety as defined by the above conditions will permit the elevation of the fountain-syringe to a height considerably less than that found necessary, by experiments, to rupture the bowel. Recent investigations on this point have been made by Rotch‡, who found that more than seventeen feet of pressure were necessary to tear the bowel of an infant, removed from the body. Forest* found that the colon of an infant would bear, without rupture, from twenty to twenty-two feet of pressure. He also found that the colon of an adult would bear, with a like result, from thirty to thirty-seven feet. Young† inserted a rectal tube into the bowel of a patient suffering from obstruction and connected it, on several occasions, with the waste-pipe of a tank which was elevated thirty feet. The patient eventually recovered from the immediate symptoms. Within safe limits will, therefore, be below ten feet in the infant, and twenty feet in the adult.

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* Thomas. Lancet, 1886, ii. 1219.

† Larrabee. Louisville Med. News, 1881, xi. 3.

‡ Rotch. Boston Med. and Surg. Jour., 1882, cvi. 322.

It should be remembered that, for diagnostic purposes, the indication is to distend the large intestine if possible, and without increasing the patient's danger. Anæsthesia should be employed ; the patient should be inverted or placed on the right side that the fluid may more readily pass up the bowel.

The objections which have been raised to the value of injections in determining the seat of the obstruction are based upon the condition of the patient and the negative value of the experiments made. It is asserted that the patient's voluntary muscles may resist the admission of the fluid; that a part of his intestine may be contracted and the rest tympanitic, with a resulting increase of the intra-abdominal pressure. The rectum may be filled with fæces, thus obstructing the entrance of fluid, or so distensible as to take in so large a quantity as to give rise to error of judgment. Again, a strictured bowel may be passable from below, but closed from above by a projecting fold of tissue. Finally, the experiments concerning the capacity of the large intestine are regarded as useless, since they are made on relaxed tissues.

These objections have a value within certain limits. If the injection is made late in the course of the disease, under slight degrees of pressure, and without anæsthesia, it may prove of no diagnostic value. If the question to be decided by injection depended upon the difference of a few ounces in the quantity of fluid admitted, the experiments on the corpse would be useless. But the diagnostic value of the injection is dependent upon a sufficient degree of pressure to overcome muscular resistance within the limits of safety, under anæsthesia. If the tympany is extreme enough to produce a doubtful result, the stomach and upper bowel may be emptied of their contents by siphonage. The quantity of fluid to be forced into the large intestine of the adult is one of several quarts or of a few pints. Since Treves* cites the case where the rectum held three pints, it is evident that, when only this quantity of fluid can be forced in, the obstruction may be at the sigmoid flexure, and that a larger quantity must be injected to ensure that the intestine above this point is passable. With these precautions and with these limitations the exploration of the large intestine by means of forced injections seems likely to prove in the future, as has been claimed in the past, a valuable diagnostic measure.

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* Forest. *loc. cit.*, 691.

† Young. British Med. Journal, 1884, ii. 706.

It may, possibly, become unnecessary for the determination of the patency of the large intestine to use the higher degrees of pressure and the larger quantities of fluid. Treves† claims that by auscultation of the cæcal region it is possible to obtain pretty conclusive evidence of the arrival of injected fluid at that point. The colon must be entirely clear and the enemata quickly introduced, in an intermittent manner, without any admixture of air. The variety of abdominal sounds to be heard in cases of intestinal obstruction is so considerable that special training in abdominal auscultation, and particularly in this affection, is regarded as necessary that this method of examination may prove of value.

Although, in general, fæcal vomiting is more likely to occur in obstruction of the small intestine than in that of the large, this relation is of no importance in determining the part of the bowel affected. It occurred in forty-seven cases of strangulation, fourteen of gall-stones, twelve of intussusception, and five of malignant disease or stricture. It was present in four cases of stricture or tumor when the obstruction was at or below the cæcum. It was noted in four cases of intussusception in the same region, below the cæcum, in two of twist of the large intestine, and in one of strangulation of this part of the bowel. Thus, in more than one-eighth of the cases of fæcal vomit, the obstruction was of the large intestine.

The physician having determined, with more or less success, the patency and capacity of the large intestine, the question which next demands consideration relates to the special variety of obstruction which may be present.

This question is best answered by an appreciation of the relative frequency of the several varieties, the knowledge of the age of the patient, the antecedent and immediate symptoms.

The published experience of the past eight years shows that for all practical purposes the following is the relative proportion of the varieties of intestinal obstruction likely to be concerned in any individual case:—

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* Treves, op. cit., 397.

† Treves, op. cit., 398.

Strangulation	101 cases	=37 per cent.
Intussusception	93 "	=34 "
Twist	40 "	=15 "
Gall-stones	23 "	= 8 "
Stricture or tumor	15 "	= 6 "
	272	100

These varieties of obstruction were seated as follows:—

	Large intestine.	Small intestine.
Strangulation	7 per cent.	72 per cent.
Intussusception	51 "	8 "
Twist	30 "	5 "
Gall-stones	0 "	14 "
Stricture and tumor	12 "	1 "
	100	100

Since obstruction of the large intestine was intussusception or twist in four-fifths of the cases, the differential diagnosis of these varieties is of especial importance. Etiology afforded no aid. The relative frequency among the sexes was the same.

If the patient is under thirty years of age the case is one rather of intussusception than of twist. Rectal tenesmus, bloody stools, and an abdominal or rectal tumor are significant of intussusception, they are not to be expected in twist. The greater the capacity of the large intestine the more likely is the presence of intussusception than twist, for the latter was found near the sigmoid flexure in 50% of the cases, while the former was found near the cæcum in 75%.

Finally, if the obstruction is not relieved by distention of the bowel and massage, with anæsthesia, there is probably an irreducible intussusception or a twist, each of which demands surgical treatment.

If the person is over thirty years of age, and there is neither tenesmus, bloody stools, nor a tumor characteristic of intussusception, the case is probably one of twist, tumor or stricture, or of strangulation. Twist was more than four times as common as strangulation, and more than twice as frequent as tumor or stricture. The latter was nearly twice as common as strangulation. The last is likely to be above the sigmoid flexure, while twist, cancer, and stricture are more likely to be at or below this point. Cancer and stricture are not infrequently within reach of the finger, hand, or sound.

They often have the antecedents of chronic pain, irregular and bloody discharges, and rectal uneasiness.

If the obstruction was seated in the small intestine, it was due to strangulation or gall-stone in more than four-fifths of the cases. The diagnosis of gall-stone was to be determined by its occurrence after the age of fifty years in six-sevenths of the cases, by previous symptoms attributed to this cause in one-half of the cases, by the usual late occurrence of the tympany on or after the fourth day, and by the occasional presence of a small, hard tumor.

Intussusception is to be differentiated from strangulation by its greater frequency in early youth, and the fact that a tumor is more often found. A twist of the small intestine is only to be differentiated by its extreme rarity.

What may be the immediate cause of the strangulation has but little practical value. At the best there is little else than numerical frequency to influence the opinion. It is desirable to remember that nine-tenths of the cases were due to adhesion, vitelline remains, or vermiform appendix, in the proportion of 63% : 21% : 6%. It is still more important to remember that, in the presence of urgent symptoms of acute obstruction, the source was to have been found in the lower abdomen in more than four-fifths of the cases.

The question, what is to be done by the physician, has already been partly answered. He is to remember that in the light of exact knowledge nearly all cases of acute mechanical, intestinal obstruction die, unless relieved by surgical interference. That curative, medical treatment has proven of sure avail only in a limited number of cases of intussusception, possibly a few of twist in the large intestine, and in certain cases of gall-stones in the small intestine. That his first duty, after relieving pain, is to determine the capacity of the large intestine. That this is best accomplished during the first two days following the initial pain, before tympany makes the task more difficult, and pathological changes cause it to be more dangerous. Finally, that the means employed for this purpose represent the most efficient curative agent in his control.

In case a diagnosis of intussusception is established, the possible benefits of medical treatment at an early stage result from the reduction of the displaced bowel. In fourteen cases where the condition of the bowel during the first five days was noted, it was found that in five, more than one-third, the bowel was irreducible on the third day. This fact should not necessarily deter the physician from an attempt at reduction at a later date. Wilson* withdrew an intussusception after seventeen days of obstructive symptoms, and the patient recovered. On the other hand, although this possibility may be admitted, sloughs of the intestine may be evacuated on the ninth day.

Notwithstanding 31% of the cases recovered without any operative treatment, it does not follow that such a recovery is to be anticipated with favor, especially if it is to be associated with the evacuation of a slough. In this class of cases eventual death from annular stenosis of the intestine is to be feared, if earlier death from peritonitis does not occur, or strangulation may take place under adhesive bands between the diseased bowel and neighboring coils. It is even possible that so much of the bowel may be detached as a slough that an insufficient quantity remains to serve for the necessary absorption of nutriment. Lanceus* for example, reports a slough of three feet of the ileum.

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* Wilson. Transylvania J. M., 1835, viii. 486.

The medical treatment of intussusception consists essentially in the use of mechanical measures for the reduction of the displaced portion of bowel. The beneficial effect of such measures is all the more possible since it is evident that spontaneous reduction may occur. Senn† observed this fact in his experiments, and Langmaid‡ records a striking illustration. His patient was an infant of five months, who, on the first day, suffered from restlessness, vomiting, and bloody dejections. On the third day a tumor, with a central indentation like the neck of the uterus, was to be felt per rectum. A cylindrical tumor was also to be recognized in the region of the descending colon. After a few hours the invaginated bowel descended to the anus. In the interval between two visits the tumor disappeared. The patient had two natural dejections on the sixth day, and recovered without further disturbance.

The mechanical treatment consists of rectal injection or inflation, preferably the former, and replacement by a repositor. Almost indispensable advantage is to be derived from the associated use of anæsthesia. Massage of the tumor and inversion of the body are important adjuncts.

The use of electricity is to be condemned as irrational where intestinal contractions induce and promote the disturbance. Large doses of quicksilver have been employed within the past few years as well as in more remote times. Gronau§ reports a case, in which, on the seventh day, one hundred and twenty grammes were given in two doses. The immediate effect was to check vomiting, although the pains persisted. A week later two copious dejections were noted, and on the following day eleven inches of ileum were discharged. The quicksilver did not appear till forty-four days after its administration.

The reduction of the displaced bowel by means of a probang or bougie, well padded at the end, seems useless from reasons already stated, in any case of intussusception where the seat is above the sigmoid flexure. Even below this point inflation or injection have proven equally serviceable, and are to be preferred as freer from risk. The earlier they are employed the better, and their use is to be avoided when there is reason to suppose that gangrene is present at the neck of the tumor, or that the latter is irreducible. It has already been stated that the tumor may be irreducible on the third day, and that a slough may be passed on the ninth day. It remains to be shown what were the limits of the successful employment of injections and inflations since 1880.

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* Lanceus (Rev. Med. Quir. Buenus Ayres). Canada Lancet, 1880-81, xiii. 260.

† Senn, *op. cit.*

‡ Langmaid. Boston Med. and Surg. Journal, 1882, cvii. 33.

§ Gronau. Berl. Klin., Wochensch., 1882, xix. 514.

Recoveries from intussusception after inflation or injection :—

Date.	Diagnosis certain.				Diagnosis probable.			
	Water.	Gas.	Air.	Total.	Water.	Gas.	Air.	Total.
1st day	--	1	3	4	2	--	4	6
2nd “	--	--	1	1	2	1	3	6
3rd “	--	--	1	1	2	--	1	3
4th “	--	--	--	--	1	--	--	1
Not given	4	--	1	5	3	--	3	6
	4	1	6	11	10	1	11	22

Deaths from intussusception after inflation or injection :—

Date.	Diagnosis certain.				Diagnosis probable.			
	Water.	Gas.	Air.	Total.	Water.	Gas.	Air.	Total.
1st day	--	--	1	1	1	--	--	1
2nd “	1	--	2	3	--	--	--	--
3rd “	3	--	1	4	--	--	--	--
4th “	--	1	--	1	--	--	--	--
5th “	1	--	--	1	--	--	--	--
	5	1	4	10	1			1

It thus appears that there were thirty-three cases of recovery after injection or inflation for certain or probable intussusception. In seventeen cases air was inflated, in fourteen water was injected, and in two gas introduced from a siphon-reservoir. It is further evident that the remedy was used on the first day in ten cases, on the second day in seven, on the third in four, on the fourth in one, and on a date not given in eleven cases. The inference from these figures is that the successful use of inflation or injection may take place on the fourth day, but is most likely to occur during the first two days.

The unsuccessful use of the above treatment resulted in eleven cases: in two on the first day, three on the second, four on the third, and in one on the fourth and fifth days respectively. Certain of these failures are due to an insufficient pressure, for after death, in these, the intussusception was easily reduced. In other cases the tumors returned, or the symptoms were not relieved. In such the tumors may not have been wholly reduced at the time of treatment. The inference is direct from the consideration of these tables showing the effect of medical treatment, that if the latter does not overcome the obstruction within the first two, possibly three, days, aid should be sought from the surgeon.

Relief, by injection or inflation, from obstruction due to a twist is of very unlikely occurrence. There is no exact evidence on this point. As in intussusception so in twist: if no relief follows inflation or injection on the second or third day, the aid of the surgeon should be sought.

The surgeon's knife offers the only hope of cure from strangulation.

In the medical treatment of obstruction from gall-stones, it is to be remembered that in the cases here collected a fatal result followed all surgical treatment, after the first week, and that five cases recovered under medical treatment after this date. The condition of the patient alone must determine the nature and duration of the treatment. Opiates, cathartics, and electricity have all been used in cases ending with recovery.

In the light of the published experience of the past eight years, the medical treatment of acute obstruction is limited to the use of injections during the first three days, under sufficient degrees of pressure, within fixed limits, to determine the patency of the large intestine. If it proves impassable the case is no longer medical, but surgical. If the large intestine is readily distended, and a diagnosis of gall-stones is admissible, and the condition of the patient is not urgent, opium is to be given; laxatives and electricity may be tried, but they are of doubtful expediency. If medical treatment is of no avail, and surgical treatment is refused, the efforts of the physician are restricted to the relief of pain and distress by narcotics, intestinal punctures, and gastric siphonage.

In conclusion, acute intestinal obstruction is diagnosticated by exclusion. Its seat is fixed by injection. Its variety is determined by its seat, the age, antecedents, and symptoms of the patient. Its treatment is surgical, on or after the third day, if the symptoms are urgent and forced injections fail to relieve.

THE SURGICAL TREATMENT OF INTESTINAL OBSTRUCTION.

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The operative treatment of intestinal obstruction is in its infancy. Since laparotomy for other indications has became an established and frequently practised procedure, a number of the bolder and more aggressive surgeons have resorted to direct measures for the relief of intestinal obstruction, but like all serious operations for otherwise incurable and fatal affections its general application has met with strong opposition not only by the laity, but also by the profession. The appalling mortality which has attended the operations in the hands of even the most competent surgeons has been quoted in the discussions of this subject in medical societies as a sufficiently strong argument in favor of non-operative interference. In this regard the history of laparotomy for intestinal obstruction is only a repetition of the history of ovariotomy. During the early part of the latter, the mortality was so great that the operation was condemned and denounced as a deliberate murder by some of the ablest and most influential surgeons. Men who had the moral courage to perform ovariotomy in the face of such bitter opposition only too often reaped a harvest of reproach for having performed their duty towards their patients. Yet in spite of all opposition the good work progressed until by an improved technique, and more especially by the introduction of antiseptic surgery, ovariotomy in the hands of experts has become one of the safest operations in surgery. To accomplish this, hundreds of lives were sacrificed that thousands might be saved. The early ovariotomists operated only on patients worn out by the disease and often the subjects of additional serious visceral lesions caused by the prolonged intra-abdominal pressure, the reason for this being the great mortality which attended the operation. To-day the danger incident to opening the abdominal cavity under proper antiseptic precautions is so slight that patients suffering from ovarian tumors are encouraged to have them removed as soon as their presence can be diagnosticated, at a time when the general health remains unimpaired, a change of practice which has still further reduced the mortality of ovariotomy. The mortality of laparotomy for acute intestinal obstruction will be reduced to that of other intraperitoneal operations, as soon as surgeons will recognize the importance of operating early before the patient's strength has been wasted by the disease, and before the parts involved in the operation have undergone irreparable textural changes. The mortality of abdominal section in the treatment of the different forms of intestinal obstruction will always be great, because the conditions which have caused the obstruction are often an intrinsic source of danger. In others the removal of the obstruction necessitates an intestinal resection which in itself is a vastly more serious operation than the removal of an ovarian tumor. Intestinal obstruction, irrespective of its cause, is always followed by a series of consecutive pathological changes which, independently of the partial, or, complete interruption of the passage of intestinal contents, tend to destroy life. The dilatation of the intestinal tube on the proximal side of the seat of obstruction may give rise to such a degree of abdominal distension as to destroy life from suspension of important function by mechanical pressure. In acute obstruction, the violent peristalsis on the proximal side of the occlusion causes an increased afflux of blood to the portion of bowel the seat of exaggerated physiological function, which after cessation of peristaltic action remains as an intense venous and capillary engorgement. During the paretic stage the blood vessels in the intestinal wall have lost their extra-vascular support, hence transudation and exudation readily take place into the paravascular tissues, which, combined with the capillary stasis attending this stage of the inflammatory process, often results in gangrene. The intestinal wall, in a state of inflammation, becomes permeable to pathogenic microörganisms which are always present in the intestinal canal, and which after passing through the entire thickness of its walls enter the peritoneal cavity and induce septic peritonitis — a frequent immediate cause of death. These facts are cogent reasons for adopting surgical measures in all cases of intestinal obstruction due to mechanical causes as soon as a probable diagnosis can be made. If this were done, the two greatest sources of immediate danger attending and following laparotomy, shock and septic peritonitis, if not entirely avoided, at least would be less likely to occur, and the tissues the seat of operation would be in a favorable condition for direct treatment and repair. An abdominal section in the treatment of intestinal obstruction is always necessarily attended by some shock, and it is therefore of the utmost importance to perform the operation at a time when the organs of circulation and the nervous system are still in a condition to successfully resist the immediate effects of the operation. Death from septic causes can only be avoided by operating at a time when the intestinal canal at the seat of obstruction and on its proximal side is still in a condition capable of resisting infection and of undergoing a satisfactory process of repair in case it becomes necessary to incise, or resect during the operation. The statistics of operations for intestinal obstruction will improve as soon as we shall be able by improved methods of diagnosis to make an early positive diagnosis and to adopt in the treatment positive surgical measures before the prospects of a recovery have been rendered improbable, if not impossible, by days and weeks of useless, and worse than useless, internal medication. True intestinal obstruction, whatever its cause may be, is as strictly a surgical affection as strangulated hernia and remediable only by the same kind of surgical treatment. Physicians should recognize this fact and should call into counsel a surgeon as soon as a probable diagnosis of intestinal obstruction can be made. To let a patient die of the consequences of a removable cause of obstruction without an operation is a reflection upon the advances of modern aggressive surgery. The difficulties which surround the diagnosis and the present imperfect technique of the operative procedures in cases of intestinal obstruction are not only responsible for the heretofore late operations, but also to a great extent for the many failures. Ways and means for more accurate diagnosis will have to be devised by more careful clinical observations and by experimental research; while new and improved methods of operation must be devised and their merits and safety tested by experiments on animals. I am convinced that accurate experimental work of this kind will render essential information in the diagnosis of the obscure causes of obstruction, and will point out more clearly the indications for operative treatment, while improved methods of operation will have to be studied exclusively in this manner. The obstacles which the surgeon encounters in the diagnosis and treatment of many cases of intestinal obstruction often appear insurmountable, but they will be greatly diminished in the future by facts which will be revealed by the results of experimental investigation. Abdominal surgery was founded and developed on American soil, and in the part which refers to the treatment of intestinal obstruction ample scope is left for the exercise of the genius and perseverance of the younger members of the profession in this country, who would do honor to the memory of our McDowell, our Sims, and our Gross by honest, faithful, unselfish original work.

I. Definition of Intestinal Obstruction.

Intestinal obstruction, occlusion and strangulation have been used as synonymous terms. Some authors wish to draw a line of distinction between cases of intestinal obstruction and intestinal strangulation, including under the former term all cases where the obstruction is caused by a tumor, enterolith, or intussusception, while internal hernia, volvulus, and constriction by a band were included under the head of strangulation. For practical purposes such a distinction is superfluous, as any cause which mechanically interferes with the passage of intestinal contents produces intestinal obstruction, and if it cannot be removed by ordinary means should be treated by abdominal section. The classification into true and false obstruction, from a surgical standpoint, should also be abandoned as operative interference is only indicated in cases of obstruction due to the presence of mechanical obstacles, such as foreign bodies, tumors, or intussusception in the lumen of the bowel, or to compression of the lumen by tumors, flexion, twisting, and bands of constriction. Inflammation of the tunics of the bowel and diffuse peritonitis may give rise to symptoms resembling obstruction, but in such cases the obstruction follows as a sequence of an antecedent, or accompanying inflammatory lesion, and is due to dynamic disturbances and not to mechanical occlusion, and the indications for treatment are to combat the inflammation and to restore peristaltic action, combined with mechanical means to relieve the abdominal distension. A more important classification remains to be mentioned by which all cases of true intestinal obstruction are divided into acute and chronic. This distinction must be maintained for many reasons. In chronic obstruction the symptoms usually develop very slowly as the occlusion becomes more complete. During the early part of the affection the intestinal walls above the seat of obstruction undergo compensatory hypertrophy, dilatation taking place very slowly unless the chronic suddenly merges into the acute form, an event which is always announced by a complexus of symptoms characteristic of acute or subacute obstruction. Chronic obstruction is more frequently met with in persons advanced in years and the seat of obstruction is usually located in some part of the large intestine. The acute form is caused by some pathological conditions which suddenly narrow, or obliterate the lumen of some portion of the intestine, usually above the ileo-caecal valve, and often without any premonitory symptoms gives rise to a complexus of acute symptoms almost pathognomonic of this affection. The sudden interruption of the passage of intestinal contents is followed by violent peristaltic action of the bowel above the seat of obstruction in a vain attempt to clear the intestinal tract, which from muscular exhaustion and the distension from the accumulation of intestinal contents finally gives rise to paresis and the textural changes previously alluded to. In such acute cases prompt action constitutes an essential element of success, as in a few hours or days, the patient becomes utterly prostrated and the bowel at and above the seat of obstruction has undergone irreparable pathological changes. These are the cases that demand early surgical treatment and will claim our special attention in the discussion assigned for this evening.

II. Frequency of Intestinal Obstruction.

An examination of the statistics of Leichtenstern* shows that, external herniæ and malignant tumors being excluded, one death from intestinal obstruction takes place in every three to five hundred deaths from all causes in hospital practice. This statement is based upon the records of the late Dr. Brinton, of London, and a number of large hospitals on the European continent.

Hilton Fagge† has shown from an examination of the records of four thousand autopsies in Guy's Hospital, from 1854 to 1868, that fifty-four, or about one-fourth of one per cent., were cases of intestinal obstruction.

Heusner‡ from his own investigations regarding the frequency of intestinal obstruction maintains that annually out of every one hundred thousand individuals from five to ten suffer from this affection, and that one to every three to five hundred deaths is attributable to this cause. These statistics show the importance of intestinal obstruction in its medical and surgical relations, and it is eminently proper that this subject should have been selected for discussion at this time and on this occasion, that by interchange of thought and experiences new light be shed upon a class of affections which heretofore, only too often, have baffled the skill of both physician and surgeon.

III. Surgical Resources in the Treatment of Intestinal Obstruction.

1. *Irrigation of Stomach.*

The accumulation of intestinal contents above the seat of obstruction acts deleteriously in several ways: 1. It causes violent peristaltic action of the intestine above the seat of obstruction. 2. It exhausts the patient's strength by causing persistent retching and vomiting. 3. It is one of the causes which produces distension of the intestine. 4. It favors fermentative and putrefactive changes in the intestine by the fluid serving the purpose of a nutrient medium for pathogenic microörganisms. In my experiments on animals where I made complete obstruction I never witnessed such persistent vomiting as in man. I attributed this difference to the fact that animals thus treated refuse, as a rule, both food and drink, and that the intestinal canal in proportion to the size of the abdominal cavity is much shorter than in man. Patients suffering from acute intestinal obstruction should abstain from taking either food or drink, as digestion and absorption are almost, if not completely, suspended, and the accumulation of fluids cannot fail in aggravating the symptoms.

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* Ziemssen's Cyclopedia of the Practice of Medicine, American Translation, vol. viii.

† Guy's Hospital Reports, 1869.

‡ Deutsche Med. Wochenschrift, 1887.

Kussmaul* has introduced a new and exceedingly valuable therapeutic measure in the treatment of intestinal obstruction in the use of the elastic stomach-tube. By the siphon action of the tube, gas and fluid contents of the stomach and upper portion of the intestinal canal are evacuated, and thus abdominal distension is relieved and the hydrostatic pressure in the intestine above the obstruction diminished. He claims for this measure the following advantages: 1. Intra-abdominal tension is diminished and thus the first condition secured for the correction of the mechanical difficulties which have caused the obstruction. 2. It relieves the distension of the bowel above the seat of obstruction and consequently also the pressure of the intestines against each other, a condition which cannot fail to impair peristaltic action. 3. Finally, what is most important, by evacuating the accumulated contents it diminishes the violent peristalsis. He reports the case of an adult where an intestinal obstruction, due to an invagination had lasted twenty-three days, and which yielded to daily irrigations of the stomach. A portion of the intussusceptum sloughed and was found in the stool. The patient died later of peritonitis which may have started from the seat of invagination.

Bardeleben† in a paper on the treatment of acute intestinal obstruction praises the utility of irrigation of the stomach as a palliative means, but speaks at the same time of the danger incident to the employment of such a temporizing measure, as too much valuable time may be lost before a curative treatment is adopted. He reports a case in which irrigation afforded such absolute relief that the operation was postponed until it could be no longer of any avail. Kuester expects from irrigation of the stomach prompt palliative effects, but warns not

* Berl. Klin. Wochenschrift, 1884, Nos. 42, 43.

† Ueber Ileus. Berl. Klin. Wochenschrift, 1885, Nos. 25, 26.

to persist with it in cases where the seat and cause of the obstruction can be ascertained. Hahn looks upon it as a curative agent only in cases where the obstruction is due to koprostasis in the large intestine, and he claims that in such cases irrigation of the rectum would lead more promptly to the desired result.

Schlegtendal* claims that lavage of the stomach in the treatment of intestinal obstruction fulfills a threefold therapeutic indication: 1. It prevents distressing symptoms, 2. alleviates them when they are present, and in some cases, 3. cures the disease.

Rehn† maintains that irrigation of the stomach, as devised by Kussmaul, in the treatment of intestinal obstruction not only empties the stomach of its contents, but it also evacuates a certain portion of the intestinal canal above the seat of obstruction. In two cases of intestinal obstruction, where this expedient was resorted to after the abdominal cavity was opened, he observed that a considerable portion of the dilated intestine was emptied of its contents.

Heusner states that by this means many litres of intestinal contents can be removed, pain is relieved, eructation and vomiting controlled, peristalsis quieted, the function of the stomach restored, suitable nourishment can be taken and assimilated, thus maintaining strength and life until the cause of obstruction is removed spontaneously, or through the intervention of surgery. Madelung has called attention to the necessity of resorting to irrigation of the stomach prior to the administration of an anæsthetic in operations for intestinal obstruction, as without such precaution there is danger during the attacks of vomiting which are almost sure to be provoked by the anæsthetic, of fluid entering the trachea, causing suffocation, or later, pneumonia.

As an aid in the treatment of intestinal obstruction due to mechanical causes irrigation of the stomach should always be systematically practised every four to six hours, but as a curative measure it should never be relied upon. In my own practice I have always combined emptying of the stomach with irrigation, using large quantities of warm water rendered antiseptic by the addition of salicylated soda, or hypophosphite of soda. The washing out of the stomach, with a harmless and efficient antiseptic solution, has a decided beneficial effect in preventing fermentative and putrefactive changes in the intestinal contents above the seat of obstruction.

2. *Distension of Colon with Fluids.*

Evacuation of the colon by copious rectal injections is resorted to almost instinctively in every case of intestinal obstruction. This procedure has also been employed with the intention of utilizing the hydrostatic pressure as a means for the correction of the mechanical difficulties which have given rise to the obstruction. This method of treatment has given rise to the much discussed question as to the permeability of the ileo-cæcal valve to rectal injections of fluids, or to the insufflation of air or gases. The majority of those who have studied this subject clinically or by experiment, make the positive assertion that the ileo-cæcal valve is perfectly competent, and effectually guards the ileum against the entrance of both fluids and gases forced into the rectum, while others insist that it is permeable only in exceptional cases, and only a few claim that its resistance can be overcome by a moderate degree of pressure.

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† Fortschritte der Medicin, 1887.

* Frauenarzt, 1887.

Heschl* made a number of experiments on the cadaver and satisfied himself that the ileo-cæcal valve serves as a safe and perfect barrier against the entrance of fluids from below. In testing the resisting capacity of the coats of the intestine he found that the serous coat of the colon gave way first to over-distension, while the remaining tunics yielded subsequently to a somewhat slighter pressure. The small intestine of a child on being subjected to over-distension ruptured first on the mesenteric side, the place where acquired diverticula are found.

Bull† has found that in the adult one litre of water injected by the rectum will reach the cæcum, but that the entire capacity of the large intestine is from four to five litres. He is of the opinion that in the living body fluid cannot be forced beyond the ileo-cæcal valve, although ancient and modern experimenters claim to have succeeded in the cadaver. He affirms that when the rectum is distended by air the ileo-cæcal valve is rendered incompetent and the air passes into the small intestines.

Cantani‡ is a firm believer in the permeability of the ileo-cæcal valve to fluid rectal injections. In one instance he treated a case of koprostasis by an injection of a litre and a half of oil per rectum, and an hour later a part of the oil was ejected by vomiting. He advises that the intestinal tract above the ileo-cæcal valve should be utilized as an absorbing surface in cases requiring rectal alimentation, and when in a diseased condition should be treated by topical applications.

Behrens§ concluded from his experiments that it required the insufflation per rectum of one and one-eighth litre of air to reach the ileum through the ileo-cæcal valve. In his experiments he had no difficulty in overcoming the competency of the ileo-cæcal valve by rectal insufflation of air.

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* Zur Mechanik der Diastaltischen Darm-perforationen. Wiener Med. Wochenschrift, 1881, No. 1.

† Virchow u. Hirsch's Jahresbericht, 1870, B. 2, p. 180.

‡ Virchow u. Hirsch's Jahresbericht, 1879, B. 2, p. 180.

§ Ueber den Werth der künstlichen Auftreibung des Dickdarmes mit Gasen u. Flüssigkeiten. Dissertation. Goettingen, 1886.

Debierré* made numerous experiments on the cadaver to test the permeability of the ileo-cæcal valve to rectal injections of fluids or insufflation of air. The results which he obtained were not constant. In some subjects the valve proved only permeable to air ; in others, to both air and water, while in some no air, or fluids could be forced into the ileum by any degree of force. When the intestine was left *in situ* the valve was found less permeable than when it had been removed from the body. He attributes the different degrees of competency of the valve to variations in the anatomical construction of the valve. If both lips of the valve are equal in length, or if the lower lip is longer, the valve was found impermeable. It proved permeable in cases where the lower lip was shorter, contracted and smaller than the upper. In the last instance the advancing volume of fluid, or air, lifted the upper valve, while in the former structure of the valve the margins of the lips of the valve were approximated, perfectly shutting off all communication between the colon and the ileum.

Mr. Lucas† enumerates the following objections against forcible rectal injections of water as a means to reduce an invagination :

1. Owing to its weight, it exerts much too strong lateral pressure for the intestine safely to bear, and he has found it easy to rupture the bowel after death by forcing in water.

2. Should reduction have been accomplished the contact of a large quantity of water with the large bowel is apt to increase the tendency to diarrhœa. He claims very properly, that gas, on the other hand, is a natural occupant of the intestinal canal, and whilst its pressure is of the gentlest, its presence excites no unnatural peristaltic action. He administers an anæsthetic to the point of relaxation before the inflation is attempted.

Dawson‡ made a number of experiments on the cadaver, and came to the conclusion that when the ileo-cæcal valve is in a normal condition, it effectually guards the small intestine against the ingress of fluids from below.

Illoway§ devised a force-pump which he strongly recommends for the purpose of forcing water beyond the ileo-cæcal valve in case the seat of intestinal obstruction is located above that point. He reports four cases of intestinal obstruction treated by this method, three of which recovered.

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* La valvule de Bauhin consíderé comme barriere des apothicaries. Lyon Medicale, 1885, No. 45.

† On Inversion with Inflation in the Cure of Intussusception. The Lancet. Jan. 16, 1886.

‡ Lancet and Clinic. 1885, Feb. 21.

§ American Journal of Medical Sciences. Vol. xli., p. 168.

Battey* asserts the permeability of the entire alimentary canal by enemata, and verifies his statement by the recital of his own clinical experience and experiments upon the cadaver. Ziemssen recommends inflation of the rectum for diagnostic and therapeutic purposes and proceeds as follows: A rectal tube about six inches long is carried into the anus and fixed by pressing together the nates, the patient lying on the back. A funnel is then connected with the rectal tube by means of rubber tubing. For complete inflation of the large intestine three drachms of bicarbonate of soda, and four and one-half drachms of tartaric acid are separately dissolved in water and portions of other solutions alternately added. To prevent sudden over-distension of the bowel it is advised to add the solutions at intervals of several minutes. A very important use of this method is to diagnosticate the position of the contractions, strictures, or occlusion of the intestine in cases in which it is desirable to operate, and also as showing the position of peritoneal adhesions. The result of his observations has led him to believe that, as a rule, the small intestine is completely closed to the entrance of substances from the colon by the ileo-cæcal valve. Under the influence of deep chloroform narcosis, however, this resistance is lessened, and fluids can be thrown into the small intestine.

Insufflation of air per rectum in the treatment of intestinal obstruction has been known since the time of Hippocrates. Gorham was the first to resort to this method of treatment in England.† In comparing the effect of enemata to air insufflation he says: "But the effect is totally different, when air is used, its freedom from all irritating qualities, its elasticity and expansibility give it a decided preference over enemata."

In my paper read at the last meeting of the International Medical Congress‡ I detailed the results of a number of experiments which I made on dogs to determine to my own satisfaction the extent to which the ileo-cæcal valve is permeable to fluids forced from below. In three cases where fluid was forced beyond the ileo-cæcal valve, in two of them the post-mortem revealed multiple lacerations of the peritoneal coat of the large intestines, while the third animal sickened immediately after the experiment was made, and died, from the effects of the injuries inflicted, eight days later. These experiments combined with clinical experience leave no further doubt that, practically, the ileo-cæcal valve is impermeable to fluids from below, and that for diagnostic and therapeutic purposes it is unsafe and unjustifiable to attempt to force fluids beyond the ileo-cæcal valve. In two cases of ileo-colic invagination, in children less than two years of age, I succeeded in reducing the bowel by steady hydrostatic pressure, while the little patients were under the influence of an anæsthetic and held in the inverted position. In both instances the invagination had existed for two or three days. We should, *a priori*, expect that air and gases on account of their lesser weight and greater elasticity than water, could be forced along the intestinal canal with less force, and for that reason alone, if for no other, should be preferred to water in cases where it appears desirable to distend the intestine below or above the ileo-cæcal valve for diagnostic or therapeutic purposes. I shall therefore call your attention briefly to

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* Transactions of the Amer. Med. Association. 1878.

† Observations on Intussusception as it occurs in Infants. Guy's Hospital Reports, vol. iii, p. 331.

‡ "An Experimental Contribution to Intestinal Surgery with Special Reference to the Treatment of Intestinal Obstruction."

3. *Rectal Insufflation of Hydrogen Gas.*

Hydrogen gas is the lightest of all known gases.* I have demonstrated by my experiments that this gas is non-toxic, non-irritant when injected into the connective tissue and into the large serous cavities, and is rapidly removed by absorption. Distension of the entire gastro-intestinal canal with this gas by rectal insufflation, both in man and animals, was never followed by any immediate or remote ill effects. Accurate experiments to determine the force requisite to render the ileo-cæcal valve incompetent by insufflation of air or gas had, previously, not been made, and as it is exceedingly important to obtain accurate information on this subject, I made a number of inflations in animals and man, estimating at the same time the pressure under which it was made, either with a mercury gauge, or a manometer such as is used by gas-fitters and plumbers. The gas was collected in a four-gallon rubber balloon and the inflation made by compressing the balloon. The manometer, or mercury gauge was connected by means of rubber tubing with the rectal tube on one side and the rubber balloon on the other. Numerous experiments showed that when the gas was forced through the opening of a stop-cock, the lumen of which was about the size of a knitting-needle, compression equal to two hundred pounds (90 kilogr.) would never register more than two and one-half to three pounds of pressure to the square inch. In the living subject the escape of gas from the rectum was prevented by an assistant, pressing the margins or the anus firmly against the rectal tube. A number of experiments made for the special purpose of measuring the resisting capacity of the ileo-cæcal valve to the entrance of gas from the cæcum into the ileum, showed that in a normal condition the valve in a healthy adult person is overcome by rectal inflation under a pressure varying from one and a half to two and one-fourth pounds (0.6 to 1.2 kilo.). This amount of pressure is not sufficient to injure any of the coats of a healthy intestine in any part of its course. As the result of numerous observations on man and animals, I can state that when the inflation is made slowly and continuously there is less danger of inflicting injury than when it is done rapidly or interruptedly. When the patient is placed fully under the influence of an anæsthetic the ileo-cæcal valve yields to a lower pressure than when the abdominal muscles are in a state of rigidity, as this interferes with the requisite degree of distension of the cæcum which is necessary to effect the separation of the margins of the valve. A rubber balloon holding four gallons (twenty litres) is the simplest, safest and most efficient instrument for making rectal insufflation both for diagnostic and curative purposes. Another series of experiments on dogs I made for the purpose of determining the degree of pressure which is required to force hydrogen gas from anus to mouth, the whole length of the gastro-intestinal canal. In all of the experiments the pressure fell rapidly after the ileo-cæcal valve had been opened, but it had again to be increased before the gas reached the stomach and escaped through the stomach tube. It usually required one-half to one pound more pressure to force gas through the entire length of the alimentary canal than when it had to be forced only through the ileo-cæcal valve. Whenever it becomes necessary to conduct the hydrogen gas a considerable distance along the intestines, or through the entire alimentary canal, it is exceedingly important to proceed slowly with the inflation, as under slow gradual distension, half a pound (0.2 kilogr.) of pressure to the square inch of surface will accomplish in time a great deal more without doing harm than four times this amount of pressure if the force is applied quickly and only for a short time. In the dog rectal insufflation of hydrogen gas made under a pressure of one-quarter of a pound, if made very slowly and uninterruptedly, the abdominal walls being completely relaxed by an anæsthetic, will not only overcome the resistance offered by the ileo-cæcal valve, but will prove sufficient to force the gas through the whole length of the alimentary canal.

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* Rectal Insufflation of Hydrogen Gas an Infallible Test in the Diagnosis of Visceral Injury of the Gastro-Intestinal Canal in Penetrating Wounds of the Abdomen. Jour. Amer. Med. Association, June 23, 30, 1888.

Experiments made on different portions of the gastro-intestinal canal when in a healthy condition and removed soon after death, proved that laceration did not take place under a pressure of less than eight pounds, and often it had to be increased to twelve pounds. It was found that the resisting power of the intestinal wall is nearly the same throughout the entire length of the canal, and in a normal condition yielded to a diastaltic force of from eight to twelve pounds of pressure. When rupture took place, it either occurred as a longitudinal laceration of the peritoneum on the convex surface of the bowel, or as multiple ruptures from within outwards at the mesenteric attachment. The former result followed rapid, and the latter slow, inflation. The superiority of hydrogen gas inflation over injections of liquids in the mechanical treatment of intestinal obstruction is apparent. Liquid injections cannot safely be forced beyond the ileo-cæcal valve, and even in distending the entire colon by liquids a great deal more force is required than by insufflation with hydrogen gas. Insufflation of hydrogen gas is a valuable means of diagnosis in locating the seat of obstruction before tympanites has set in and therefore best adapted at a time when most needed—during the early stage of intestinal obstruction. If the colon dilates uniformly from the sigmoid flexure to the cæcum the obstruction must be sought for higher up in the intestinal canal. The passage of gas through the ileo-cæcal valve, rendered incompetent by the distension of the cæcum, is always attended by a characteristic gurgling or blowing sound which is always heard most distinctly by applying the ear or stethoscope over the ileo-cæcal region. Not infrequently the sounds are so loud and distinct that they can be heard at a distance of several feet. If the gas passes the ileo-cæcal valve under a pressure not in excess of that required to overcome it in a state of health, and, if after inflation a thorough examination of the ileo-cæcal region by inspection, palpation and percussion reveals nothing abnormal, the search for the obstruction is continued by inflating the small intestines slowly and making frequent examinations of the abdomen to ascertain the height to which inflation has been made and to study the relative position of the different abdominal organs. Inflation is also a useful diagnostic resource in locating the obstruction during laparotomy for intestinal obstruction. The intestine below the seat of obstruction is always empty, collapsed and anæmic as compared with the portion above the obstruction. When the obstruction is located high up in the intestinal canal and the tympanites is extensive the empty portion of the small intestines has by compression become displaced and is often not readily found. In such cases the distension of the bowel from below will indicate to the surgeon at once the location and length of the intestine below the seat of obstruction and will enable him to search for the obstruction from below upwards. The manipulation of the healthy intact portion of the intestinal canal in the search for the obstruction is by far a less hazardous procedure than the handling of the distended portion above the obstruction rendered paretic, exceedingly vascular, and much softened by the obstruction. In cases where we suspect the presence of a perforation, inflation with hydrogen gas will demonstrate not only its existence, but also its location. Invagination is rare above the ileo-cæcal valve, and its location can be determined by inflation with hydrogen gas, and if resorted to early it may prove the means of effecting reduction. In ileo-cæcal and colonic invagination slow and persistent distension of the colon with hydrogen gas, with the patients completely under the influence of chloroform, is the safest and most efficient means of effecting reduction and should always be resorted to whenever these conditions are recognized or even suspected. Rectal inflation as ordinarily practised by forcing air into the rectum with bellows, or a Davidson's syringe, is not devoid of danger, as the force employed cannot be accurately regulated or estimated.

Bryant* has collected twenty cases of invagination treated by inflation, in three of which it produced rupture of the bowel below the invaginated portion, while in a fourth the child died in collapse shortly after the inflation. He does not look upon inflation as a proper and safe method of treatment in cases of acute invagination, and in the subacute form it should only be resorted to within the first three days, because later on changes in the bowel are almost certain to have taken place, which would render this measure fruitless, and probably dangerous.

Knaggs† reports the particulars of eight cases of invagination where forcible distension of the bowel by air or water was the cause of rupture or other serious injury to the bowel. These cases show that this method of treatment is attended by great risk in children less than one year of age, as six of the eight cases in which harm resulted were children less than eight months old. In Symond's case the abdomen was opened at once after rupture had taken place, and the rupture was sutured. The child, however, was too exhaused to rally from the operation, but at the necropsy the sutured bowel was able to resist successfully very considerable distension with water.

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* Harveian Lectures on the Mode of Death from Acute Intestinal Strangulation and Chronic Intestinal Obstruction. British Medical Journal, 1884, Nov. 22.

† Resection of an Irreducible and Gangrenous Intussusception, etc. The Lancet, 1887, June 4, 11.

Greig* reports five cases of invagination treated by insufflation of air, in four of which it proved successful. In some of the cases the insufflation had to be repeated.

Insufflation of hydrogen gas from a rubber balloon is applicable in all cases of sub-acute and chronic invagination and during the early stage of acute invagination, that is before the passive hyperæmia in the invaginated portion has rendered reduction by this method impossible. Should perforation take place the accident is at once recognized by a uniform distension of the abdomen from the entrance of the hydrogen gas into the peritoneal cavity, as well as by a sudden diminution of pressure readily felt by the person who makes compression of the balloon. The entrance of hydrogen gas into the peritoneal cavity is in itself a harmless occurrence as the gas is non-irritant and perfectly aseptic. In such cases the insufflation must be followed at once by abdominal section and the necessary operative treatment of the invagination.

4. *Tubage of Colon.*

Even a few years ago it was as much a mooted point in reference to how far fluids could be forced beyond the rectum as the permeability of the ileo-cæcal valve is at the present time.

Von Trautvetter† made numerous experiments on the cadaver to determine how far up into the bowel fluids could be injected per rectum. He injected either with an ordinary syringe or through a rectal tube. The fluid used was a solution of ferrocyanide of potassium, and after the injection chloride of iron was applied to different parts of the intestine to test for the presence of the fluid injected. Ordinary injections did not pass beyond the lower portion of the descending colon, while injections made through a long elastic tube reached the cæcum. These experiments are only alluded to as an illustration of the ideas which were entertained in reference to the permeability of the colon to rectal injections at the time O'Bierne first advocated the use of the elastic rectal tube in cases where it was deemed necessary to make high injections. Some authors suggest the introduction of a rectal tube in the treatment of intestinal obstruction as first practised by O'Bierne and claim that with it they have reached the cæcum; but Treves assures us that he has made numerous experiments on the cadaver and has never succeeded in passing it farther than the sigmoid flexure.

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* On Insufflation of Air as a Remedy in Intussusception. Edinburgh Med. Journal, October, 1864.

† Wie weit können Fluessigkeiten in den Darmcanal per anum hinauf gespritzt werden? Deutsches Archiv f. klinische Medicin, B. IV, p. 476.

Cadge* states that even O'Bierne never claimed that the elastic rectal tube could be inserted farther than the sigmoid flexure. Cadge made numerous attempts on the cadaver and was never able to reach the descending colon. In cases where the tube was introduced to a depth of twenty to thirty inches he found that the tip of the instrument remained in contact with the intestinal wall, and that this portion of the bowel is pushed forward when the end of the instrument can be felt through the abdominal wall at a higher point. In the administration of ordinary injections the introduction of a rectal tube is superfluous, as in Hegar's knee-chest position the fluid from an ordinary fountain syringe will follow the course of the colon and advance as far as the cæcum.

Hegar† seldom found it necessary to elevate the funnel more than one foot, a column of water corresponding to this elevation being found sufficient to force the fluid as far as the cæcum and as he believes sometimes beyond the ileo-cæcal valve. The legitimate indications for tubage of the colon are the following:

1. Detection and location of obstruction below the sigmoid flexure.
2. To relieve gaseous distension of the colon.
3. To administer high nutrient enemata in cases where it becomes necessary to maintain the strength of the patient by this method of alimentation.

5. *Manual Exploration by the Rectum.*

The introduction of the whole hand into the rectum as a means of diagnosis was devised and first practised by Simon. This method of exploration is only applicable in the adult. Simon and his numerous followers claim that the hand can be introduced sufficiently far to enable the surgeon to palpate most of the abdominal organs. Nussbaum assures us that he has felt more than once the tip of the sternum with the hand employed in the manual exploration by the rectum.

Wagstaff ‡ places great stress on the importance of manual exploration by the rectum as a diagnostic measure, as appears from one of his conclusions: "That the causes of obstruction can generally be determined by the history of present and past illnesses and by thorough external examination, and that manual exploration by the rectum is certainly the greatest advance in our means of diagnosis." The glowing accounts of the value of this method of exploration were soon followed by the report of disastrous consequences such as rupture of the gut and permanent loss of function of the sphincter muscles. Manual exploration by the rectum should only be undertaken by surgeons with small slender hands, and the examination should be made with the patient fully under the influence of an anæsthetic and always with the utmost care and gentleness. This method of examination will enable the surgeon to ascertain the location and nature of obstructions below the sigmoid flexure, the existence of volvulus at the sigmoid flexure, and to determine the presence of pathological conditions in the pelvis which might have caused the obstruction. As a therapeutic measure this procedure can be employed in the removal of foreign bodies or an enterolith within reach of the hand, and in the reduction of some cases of intussusception where the invaginated portion of the bowel has passed beyond the sigmoid flexure.

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* Case of Intestinal Obstruction with Remarks. British Medical Journal, 1888.

† Ueber Einführung von Flüssigkeiten in Harnblase und Darm. Deutsche Klinik, 1873, No. 8.

‡ On Intestinal Obstruction. St. Thomas' Hospital Reports, New Series, vol. iv, 1873.

6. *Taxis and Massage.*

Hutchinson decidedly opposes early operative interference in cases of intestinal obstruction, and expects little from it in those which have been some time in existence. He advocates what he terms *abdominal taxis*, under an anæsthetic. By abdominal taxis he means a thorough kneading of the abdomen, with inversion of the patient, shaking him, tossing him in a blanket, and a variety of rough performances, the object being to dislodge the bowel, or untwist the volvulus. At the same time he advises large enemata and cathartics. If these means do not lead to the desired result he waits and keeps the patient on a low diet, and administers opium or belladonna internally, and subsequently repeats the abdominal taxis. He reports a number of cases successfully treated by this method. It is doubtful if any surgeon at the present time could be found who would be willing to subject his patients to such a primitive treatment as advised by Hutchinson. In most forms of intestinal obstruction such treatment is not only unscientific and useless, but attended by great risk to life, as the violent movements would not only aggravate the mechanical difficulties which have caused the obstruction, but might produce rupture of the distended intestine, and could not fail in causing exacerbation of the vascular disturbances. Taxis and massage scientifically practised have a limited range of application in the treatment of intestinal obstruction when it is due to the presence of a foreign body, a fæcal accumulation or an enterolith, and should only be resorted to before these causes have developed inflammatory changes at the seat of impaction. A number of such cases are on record where this treatment proved successful.

Streubel* succeeded in a boy eleven years of age suffering from intestinal obstruction due to the impaction of a mass of cherry stones above the ileo-cæcal valve in removing the cause of obstruction by submitting the swelling to gentle massage frequently repeated.

Marotte† gives an account of a case of acute intestinal obstruction which had lasted for some days when fæcal vomiting set in, and in which the usual internal treatment with opiates and chloroform afforded no relief, which was promptly cured by palpation of the abdomen made for the purpose of locating the seat of obstruction. The patient experienced a sensation at the time as though the obstruction had given way and soon afterwards had a number of evacuations in which a gall-stone the size of a walnut was found. The author refers to five cases of intestinal obstruction caused by the presence of gall-stones, collected by Fauconneau-Dufresne. One of these cases came under the observation of Mayo. In this case the gall-stone was also dislodged by palpation, followed by cessation of the symptoms of obstruction and recovery of the patient. The remaining four patients died. In cases of fæcal accumulation in any portion of the large intestine from the cæcum to the sigmoid flexure unattended by inflammation and giving rise to symptoms of obstruction, and not amenable to irrigation of the colon, massage and taxis should be made while the patient is under the influence of an anæsthetic so as to enable the operator to break up the mass and to force it onwards in the interior of the bowel to a point where peristaltic action is more active.

7. *Puncture of Intestine.*

Advanced cases of intestinal obstruction are always attended by great distension of the bowel on the proximal side of the obstruction, a condition which causes increased intra-abdominal pressure. The tympanitic distension of the abdomen may be so great as to destroy life by the suspension of important functions from mechanical pressure. The diaphragm is pushed upwards so far that death may ensue from asphyxia, or the circulation is so far impeded by compression of the heart as to cause death from syncope. Great distension of the intestines on the proximal side of the obstruction also aggravates the mechanical difficulties which have caused the obstruction, as the dis-

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* Ueber Erkennung und Behandlung der inneren Darmeinklemmung. Prager vierteljahrsschrift, B. XV, 1858.

† Einklemmung eines Gallen-steines im Darme. Heilung durch Palpation des Bauches. Schmidt's Jahrbücher, B. 93, p. 189.

tended bowel under such circumstances forms numerous flexions which interfere with the free passage of its contents as far as the obstruction, at the same time the distended coils may render the bowel less permeable at the seat of obstruction by compression. The anxiety with which surgeons look upon extensive tympanites following the course of intestinal obstruction is universal, hence it is only natural that for a long time it has been customary to make attempts in affording relief by puncturing the distended bowel through the abdominal wall. A small trocar was usually employed for this purpose and since the introduction of the hypodermic needle and the aspirator a hollow needle of one of these instruments has been used. Cases have been reported where repeated punctures not only afforded relief, but finally led to a permanent cure. In some instances the cannula of a trocar after puncture was allowed to remain until a fæcal fistula had been established. An intestine distended to the extent of giving rise to distressing and dangerous intra-abdominal pressure is always in a paretic condition, unable to expel its contents and whatever escapes through a needle or the cannula of a trocar is expelled by the contraction of the abdominal wall. This applies not only to the liquid, but also to the gaseous contents. I have repeatedly satisfied myself during operations on the living subject, and in animals where the obstruction was caused artificially that mere puncture empties only a limited space not more than six to eight inches on each side of the puncture. If aspiration is practiced at the same time the effect is doubled ; further evacuation is arrested by flexions among the distended coils and valvular closure of the collapsed segment of the intestine at the terminus of the evacuated area. The recorded results of puncture of the intestine represent largely only the successful cases, while the numerous failures seldom find their way into literature. Puncture of a healthy intestine with a needle of moderate size is never followed by extravasation, as the irritation incident to the puncture always produces muscular contractions which start from the point of puncture and at once obliterate the canal made by the needle. Puncture of a paretic intestine is always attended by great risk of extravasation, as the muscular coat has lost its tonicity and the track of the needle or trocar is slower in closing, or remains permanently patent. Numerous cases have been reported where a mere needle puncture gave rise to escape of fæcal contents into the peritoneal cavity. As the removal of the tympanites is the means only in exceptional cases of removing the cause of obstruction, and as the puncture of a distended paretic intestine is never devoid of risk of causing fæcal extravasation the legitimate indications for puncture of the intestine are extremely limited. If employed at all puncture is only applicable to cases where no mechanical obstruction is present, and where the rapid distension of the abdomen, in itself, constitutes an imminent source of danger. Puncture should never be resorted to with a view of removing liquid contents; its use should be limited to the evacuation of gases. For this purpose one of the smaller needles of an aspirator should be used. The point of the needle should be sharp so that it can be readily passed through the intestinal wall. The needle should always be thoroughly disinfected by heating it in the flame of an alcohol lamp. The point of puncture should be made at the most prominent point and the instrument pushed boldly forwards until all resistance is overcome. As soon as gas escapes the intra-abdominal pressure should be increased by gentle and uniform compression of the abdominal walls. As soon as gas ceases to escape aspiration should be made and continued as long as anything can be evacuated, and until the needle is withdrawn but not at the time it is withdrawn. Should it be possible to ascertain the location and direction of the part of the intestine to be punctured, it is advisable to make the puncture obliquely in the long axis of the bowel so as to guard more effectually against extravasation.

8. *Uniform and Uninterrupted Compression of the Abdomen.*

In all cases of intestinal obstruction, but more particularly in the chronic form, uniform firm support of the abdomen affords relief to the patient and is one of the best means of preventing rapid distension of the intestine above the seat of obstruction. Fixation and equable compression are resorted to in other parts of the body as the best known means in controlling muscular spasm. It is only reasonable to expect that the same measures should prove useful in retarding, if not preventing, the violent peristalsis in cases of intestinal obstruction, and especially in preventing over-distension of the intestine. Equable compression of the abdomen should be made before great distension has occurred. Uniform compression of the abdomen is best secured by padding the iliac regions with absorbent cotton and then enveloping the body from the pubes to the tip of the sternum with broad strips of adhesive plaster which should be made to overlap each other.

9. *Enterotomy.*

In 1840 Nélaton made the first enterotomy for intestinal obstruction. He conceived the propriety of such an operation from Mannoury, who in his thesis in 1819, first called attention to the formation of a preternatural anus in cases of intestinal obstruction. Nélaton taught that by opening the abdomen in the right inguinal region and seizing the first distended coil that might present the surgeon almost without exception would establish the artificial opening in the bowel near the ileo-cæcal region. The mortality of enterotomy has been nearly as great as that of laparotomy with removal of the cause of obstruction and on this score alone its further application should be limited to exceptional cases, cases where a radical operation is inadmissible on account of the nature of the obstruction or the enfeebled condition of the patient. No one who under the pressure of circumstances has been forced to establish a preternatural anus has left his patient with a feeling of satisfaction, as he must have been sadly impressed with the fact, that, at best, he has only succeeded in relieving the urgent symptoms of the obstruction, while he has failed in removing the cause, and consequently also in restoring the continuity of the intestinal canal. A patient with an artificial anus is indeed an object of pity, as experience has sufficiently demonstrated how difficult it is in many instances to close the abdominal opening, even after the cause of obstruction is subsequently removed or corrected spontaneously, without exposing him a second time to the risks of life incident to another abdominal section. If the causes which have led to the obstruction are of a permanent character, all attempts at closing the fistulous opening will, of course, prove worse than useless, and the patient is condemned to suffer from this loathsome condition for the balance of his life-time without a hope of ultimate relief. I believe I can safely make the statement without fear of contradiction that most of these unfortunate patients would prefer death itself to such a life of misery.

In performing enterotomy the surgeon has no means of selecting the most desirable place in the intestine for making the opening. The only rule laid down by the text-books, and the only one applicable in such a case, is to secure in the wound and open the first distended loop which presents itself. It not infrequently happens that the opening is made far above the seat of the obstruction, an occurrence which is attended by two immediate sources of danger: 1. Physiological exclusion of a large portion of the intestinal canal, which in the event the patient recovers from the operation and the cause of obstruction remains permanent is followed by marasmus which in itself may prove the cause of a subsequent fatal issue. 2. The portion of intestine between the artificial opening and the seat of the obstruction being the part which has suffered the most from the effects of the obstruction remains distended and continues to exert the same deleterious effect as before the operation. Many able surgeons, even at the present time, prefer enterotomy to laparotomy and mention as principal arguments in its favor that it requires less time in its execution and can therefore be resorted to in patients where a radical operation for this reason alone would be inadmissible ; again, it is claimed that the intestine above the seat of obstruction is not in a condition for direct operative measures which have in view the restoration of the continuity of the intestinal canal. It must, however, not be forgotten that in quite a number of cases the second objection to a radical operation does not apply, as the removal of the cause of obstruction is accomplished without interrupting the continuity of the intestinal canal, and as I shall show further on, in the remaining cases, where the cause of obstruction cannot be removed the continuity of the intestinal canal can be restored by making an intestinal anastomosis which can be done without greater immediate or remote risk of life than attends enterotomy. As the technique of radical operations for intestinal obstruction will be improved, the indications for enterotomy will diminish. As long as the patient's strength warrants a radical operation enterotomy should never be performed. In patients so enfeebled that the administration of an anæsthetic would be attended by imminent danger to life an enterotomy can be made without anæsthesia and under such circumstances will be the means of occasionally saving a life which otherwise would be lost. The operation is performed by making an incision not more than two and a half inches in length in the right iliac region, above and parallel to the outer half of Poupart's ligament. The tissues should be recognized as they are divided, without, however, using a director until the subperitoneal fat is reached. This layer is divided bluntly and pushed aside when the peritoneum comes into view. This membrane is seized with a toothed forceps or lifted up with a sharp hook and carefully incised and divided upon a grooved director. The peritoneum is united all around with the skin by a continued suture. Almost without exception, a distended knuckle of intestine, readily recognized by its size and color, presents itself in the wound, and is united with the external wound ; and after it is securely fastened, an incision large enough to admit the tip of the index finger is made in the bowel and the margins of the visceral wound sutured separately to the external wound by a single suture on each side, so as to secure patency of the opening. On incising the bowel the surgeon is often disappointed at the small amount of gas and fluid which escape, and it is frequently several hours before a free escape takes place and the abdominal distension begins to diminish. The escape of intestinal contents is expedited by the introduction of a large sized Nélaton's catheter.

10. *Colotomy.*

Colotomy will always retain a place in operative surgery as a palliative and life-prolonging procedure in the treatment of carcinomatous stenosis of the lower portion of the colon, and in cases of inoperable carcinoma of the rectum. The recent advances in abdominal surgery have rendered the old-fashioned lumbar or extra-peritoneal operation obsolete. The modern operation is made by opening the peritoneal cavity in the right or left groin according to the indications which are to be fulfilled, and one of its principal objects is to terminate the intestinal canal at the artificial anus so as to provide absolute physiological rest for the portion of the bowel below it. The obvious disadvantages of colotomy, as usually performed, are cited by Maydl* as the reasons which induced him to devise the operation which he has described. He opens the peritoneal cavity by Littre's incision, and draws a loop of intestine forward till its mesenteric attachment is on a level with the external incision. Through a slit in the mesentery close to the gut is inserted a hard rubber cylinder wrapped in iodoform gauze ; a goose-quill will answer the same purpose. This device holds the intestine in the wound and prevents its return into the abdominal cavity. By means of a row of sutures placed on each side of the prolapsed gut, including the serous and muscular coats, the two limbs of the flexure, in so far as they lie in the abdominal wound, are stitched together beneath the rubber support. If the intestine is to be opened immediately, it is stitched to the parietal peritoneum of the abdominal incision and the latter protected by iodoform collodium. If the bowel is to be incised later, the latter is not stitched to the peritoneum, but surrounded by iodoform gauze packed in beneath the rubber support, the incision of the bowel being made four or six days later after the peritoneal cavity has been excluded by firm adhesions. If the artificial anus is made for lesions incapable of subsequent removal, a transverse opening including one-third of the periphery of the bowel, is made by the thermo-cautery, drainage tubes are inserted into the two lumina, and the intestine is carefully washed out. If the progress of the case is satisfactory the bowel is cut through completely in two or three weeks, the rubber support serving a useful purpose as a guide in making this incision, a few sutures will serve to secure the cut end to the skin. If the direction of the muscular fibres has been respected in making the abdominal incision, the patient is provided with such an efficient sphincter that a large drainage tube is required to keep the opening patulous.

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* Centralblatt f. Chirurgie, 1888, No. 24.

Should the artificial anus only be a temporary one the incision in the intestine is made in a longitudinal direction. When it has become desirable to close the artificial opening, the rubber support is removed, after which the bowel retracts and the opening often closes without any further treatment. If the adhesions are too firm for this they are removed and the bowel is sutured and returned into the peritoneal cavity. Lauenstein accomplishes the same object by suturing first the peritoneum to the skin, thus lining the external incision by peritoneum, then drawing out a loop of intestine and closing the parietal wound by sutures passing through the meso-colon of the prolapsed portion of intestine which is thus fastened in the abdominal incision ; next the serosa of each limb of the prolapsed loop is stitched through its entire circumference to the parietal peritoneum.

An interesting discussion has arisen lately in Germany in regard to a step in the operation of colotomy which was described by Knie.* So far the operation has been only done on dogs. It consists in opening the abdomen transversely in the region of the transverse colon, stitching the peritoneum to the edges of the wound, drawing out the colon, making a slit in the meso-colon near the gut with a blunt instrument and closing the abdominal wound with two or three sutures, which are passed through the slit in the meso-colon. The object of this is to secure a loop of the colon outside of the abdominal cavity. This loop is to be carefully stitched at each side to the edge of the (now) two abdominal openings, after which it is to be opened by an incision, or if the symptoms are not urgent the incision is postponed for a few days until the peritoneal cavity has been shut off by adhesions. As a general thing Lauenstein's operation will be found simplest and should receive the preference in ordinary cases. The modern operation of colotomy is indicated in cases of congenital atresia of the rectum when the bowel cannot be readily reached from below ; also in cases of carcinoma of the sigmoid flexure and the rectum not amenable to a radical operation. Finally the operation might become necessary in irreducible colic invagination in which for anatomical reasons resection or anastomosis cannot be done.

11. *Abdominal Section.*

A radical operation in the treatment of intestinal obstruction embraces the fulfillment of two principal indications: 1. The removal or rendering harmless of the cause of obstruction. 2. The immediate restoration of the continuity of the intestinal canal. To meet the first indication the cause of the obstruction must be found, its nature determined, and whenever advisable or practicable, it is removed, a step in the operation which may be very easy, or may demand a most formidable and serious undertaking, more especially in cases where the pathological conditions which have given rise to the obstruction are of such a nature as to constitute in themselves an imminent or remote source of danger, as, for instance, malignant disease or gangrene of the bowel from constriction. Abdominal section in the treatment of intestinal obstruction has so far been attended by a fearful mortality. Owing to the fact that most operations were performed when the patients were in collapse, or when the parts involved in the obstruction had undergone advanced and often irreparable pathological conditions.

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* Centralblatt f. Chirurgie, May 5, 1888.

Ashhurst* tabulated fifty-seven cases of laparotomy for acute intestinal obstruction from other causes than from intussusception, from which it will be seen that only eighteen terminated favorably, so that at that time the mortality of laparotomy in cases of intestinal obstruction other than intussusception, was over 68 per cent. Most of these operations were performed without antiseptic precautions.

Schramm has collected one hundred and ninety cases of intestinal strangulation treated by laparotomy, including three cases observed by himself in the practice of Mikulicz. He alludes to the difficulties encountered in the diagnosis of these cases and pleads in favor of early operative interference. Of this number 64.2 per cent. died, the mortality before the antiseptic treatment of wounds being 73 per cent., and since that time 58 per cent. The cause of strangulation and mortality attending each kind may be gleaned from the following table :

27	times,	Invagination,	8 cured,	19 died.
49	“	Bands, or intestinal diverticula	13 “	36 “
16	“	Adhesions,	7 “	9 “
11	“	Reduction *en masse*,	6 “	5 “
10	“	Torsions,	1 “	9 “
12	“	Knotting of bowel,	4 “	8 “
12	“	Internal strangulation,	4 “	8 “
7	“	Foreign bodies,	4 “	3 “
38	“	Neoplasms,	16 “	22 “
8	“	Unknown causes,	4 “	3 “

Curtis† has collected the cases of intestinal obstruction treated by abdominal section since the year 1873, consequently since the antiseptic treatment of wounds was introduced. Table I. shows a total of three hundred and twenty-eight cases with one hundred and two recoveries and two hundred and twenty-six deaths, the percentage of mortality being 68.9—a higher percentage than that of Schramm's collection. Table III. shows that in one hundred and one cases, the failure of the operation was due directly to the unfavorable condition of the patient, who was in a dying condition in eight cases. In the majority of the cases with complications, forty-one in all, the fatal result was also really due to the condition of the patient, for the existence of peritonitis or gangrene of the bowel at the time of operation shows that there had been too much delay in resorting to operative measures and most of these cases died a few hours ofter operation. In twenty-eight cases the cause of obstruction was not found, or could not be removed, and in eleven the reports are so defective that the cause of death cannot be ascertained from them. Of the remaining forty-five fatal cases, thir teen died of shock, in three cases the unusual length of the operation was probably the direct cause of death, and in seventeen cases, sepsis, probably due to the operation was the cause of death. In twelve cases the cause could not be definitely learned, but as death was followed in most of them within twenty-four hours after the operation, it was probably shock and exhaustion. In two hundred and forty-seven cases where the cause of obstruction was removed, the mortality was only 62.7 per cent.; while in forty-seven in which it was not done, the mortality was 86.4 per cent. In forty-one cases where the obstruction consisted of invagination, volvulus, adhesions, bands and internal incarceration, in which the obstruction was not removed, not a single one recovered, although in sixteen an artificial anus was made.

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* Amer. Jour. Med Sciences, July, 1874.

† The Results of Laparotomy for Acute Intestinal Obstruction. Annals of Surgery, May, 1888.

The greatest mortality attended cases where from any cause suturing of the bowel was made, attaining the extreme point of 86.6 per cent. in forty-five cases. The necessity for a short operation is well shown by the cases collected by Curtis, which give a mortality of 57 per cent. in one hundred and ninety cases in which the operative interference was limited to relieving the obstruction, without wounding the bowel, while it rose to 73 per cent. in fifteen cases in which it became necessary to establish an artificial anus after the obstruction had been removed, and to 83 per cent. in forty-eight cases in which the gut had to be sutured. In all these cases the true danger lay in the length of the operation, for death resulted from the immediate effects of the operation in most of the cases. These statistics show the value and importance of an early operation, as sometimes delay of only a few hours will bring complications which not only necessitate more time in their removal, but will at the same time necessitate a resection or an anastomosis, which, had the operation been done at an earlier date, might have been obviated. The older text-books on surgery always cautioned the practitioner to postpone the operative treatment of a strangulated hernia for a certain length of time which was often consumed in vain attempts at reduction, consequently the old statistics of herniotomy present a high mortality when contrasted with recent operations. This striking contrast was brought about not solely by an improved technique, or by the introduction of antiseptic surgery, but it is largely owing to the modern teaching that it is dangerous to delay an operation, if the strangulation is not relieved by gentle taxis persisted in not for hours and days, but only for fifteen minutes, and at the utmost for half an hour. Modern surgery recognizes the safety of an early operation for strangulated hernia, and the results which have been obtained have demonstrated the wisdom of the change in practice. Vain and prolonged attempts at reduction of a strangulated hernia aggravate the causes which have produced the strangulation and hasten the pathological changes in the strangulated intestinal loop which arise from the strangulation. If delay is dangerous in a case of strangulated hernia, what can we expect of a laparotomy for intestinal obstruction when postponed until the patient has been exhausted or the local conditions necessitate complicated operative measures? In strangulated hernia the destructive changes in the constricted intestinal loop affect by continuity and contiguity primarily only a limited peritoneal surface, while in intestinal obstruction the seat of obstruction is in direct communication with the entire peritoneal cavity which becomes the seat of a rapidly fatal septic inflammation if gangrene or perforation have caused the inflammation. A recent intestinal obstruction due to a change of visceral relations such as flexion, volvulus, and invagination if subjected to operative treatment before consecutive pathological changes have occurred would offer but little difficulty to mechanical correction of the displacement, and as in such cases the intestinal tube would be in a healthy intact condition the danger of the operation would not be greater than that of an ordinary ovariotomy. I think enough has been said in favor of an early operation in all cases where the signs and symptoms indicate the existence of an obstruction which does not yield to milder measures. Intestinal obstruction is a surgical lesion in every sense of the word, and should be treated from the very beginning upon common sense surgical principles. To temporize with such cases by the administration of uncertain drugs must be looked upon as evidence of ignorance or a relic of barbarism. The treatment of a case of intestinal obstruction upon the expectant plan until gangrene or perforation has taken place, which, if submitted in time to proper surgical treatment, might have been cured by one stroke of the scissors should be considered as gross negligence for which the modern aggressive physician and surgeon can offer no justification or apology. The future progress of abdominal surgery will conquer the difficulties which now surround the diagnosis and treatment of intestinal obstruction. Experimental research and more careful and accurate clinical observation will solve the difficult problems which now surround us in this as yet unexplored field of surgical labor. Laparotomy for intestinal obstruction should not be undertaken by every tyro in surgery. The one who undertakes it should be master of the situation, familiar with every detail of the technique of different operative procedures and fully conversant with the manifold complications with which he may be confronted. Every possible contingency must be fully considered before the abdomen is opened, as this is an operation where unnecessary hesitation and loss of time weigh heavily in the balance on the side of failure. Like other abdominal operations laparotomy cannot be mastered in the lecture room or even under the tuition of experienced surgeons. Those who expect to perform this operation must, in the first place, have a perfect knowledge of the structure and relations of all the abdominal organs in conditions of health and disease and must acquire the necessary operative skill on the cadaver, and then what is still more important, should make the more important operations on the living animal. It is not necessary or even desirable that every physician should become a laparotomist, but in every section of the country, distant from the medical centres, some one should interest himself in this branch of surgery and prepare himself to meet such emergencies. Unlike a patient suffering from an ovarian tumor, patients affected with acute intestinal obstruction cannot be transported great distances, and as loss of time leads to disastrous consequences it is not always possible to secure the services of a surgeon versed in abdominal surgery from a distance, and for such contingencies I should recommend that at least one member of every county or district medical society should familiarize himself sufficiently with the details of intestinal surgery, so that patients in his neighborhood may reap the advantages of modern aggressive surgery at the proper time and at their own homes.

a. Preparations for the Operation.—The most careful and perfect preparations should be made for the operation. The presence of at least three reliable and intelligent assistants is an absolute necessity. As an exventration may become necessary and exposure of the intestines to a cool atmosphere is productive of shock an equable temperature of from 80° to 85° F. should be maintained in the operating room from the beginning to the end of the operation. Opinions among operators may still differ as to the wisdom or even propriety of using antiseptics in a healthy peritoneal cavity, but no one at the present day would have the courage to oppose the use of *strictest antiseptic precautions in securing an aseptic condition for everything that will come in contact with the wound or the peritoneal surfaces.* The operating room must be cleared of everything, except the bare walls and windows, and the whole of its interior surface washed with a strong solution of sublimate or carbolic acid. The table and stands are disinfected in a similar manner. The blankets if not perfectly aseptic can be covered with linen sheets. Heat is the most reliable, safest and cheapest sterilizer, and can be used for the disinfection of towels, napkins, instruments and wash-basins. *The operator must satisfy himself of the aseptic nature of everything which is used inside of the peritoneal cavity.* The abdomen of the patient and the operator's and assistants' hands are rendered aseptic by washing with potash soap and warm water, and afterwards with a 1-1000 solution of sublimate. The water used for solutions and sponges is sterilized by boiling. For the protection of prolapsed intestine, compresses of aseptic gauze or napkins are better than sponges, and the temperature of the parts is maintained, not by pouring warm water on the compresses, but by removing them and applying new ones wrung out of warm water. The danger of using corrosive sublimate solution within the peritoneal cavity is well shown by Kümmell's experience.* He made nine laparotomies, using for the sponges a 1-5000 solution of sublimate and all of the patients recovered without an unpleasant symptom. Then he met with two cases of sublimate intoxication in succession, having used the same strength of the solution. One of the patients died on the fourth day and the post-mortem revealed intestinal lesions characteristic of acute mercurial poisoning. The other patient recovered after a lingering illness, during which the symptoms of mercurial intoxication were well marked. He cautions against the use of sublimate in debilitated, anæmic individuals, or in patients suffering from renal disease. In cases where the peritoneal cavity is in a healthy aseptic condition the use of any of the stronger antiseptics is contra-indicated. For the cases where septic peritonitis, suppuration, gangrene or perforation exists, a two per cent. solution of boracic acid, or a saturated solution of salicylic acid (0.3 per cent.) should be kept in readiness for flushing the abdominal cavity. Bands of rubber or fine rubber tubing should always be on hand as well as a good assortment of aseptic silk, well prepared catgut, glass drains, decalcified perforated bone plates, and a good assortment of needles and forceps. Stimulants and means to make auto-transfusion must never be absent, as prompt interference when symptoms of shock make their appearance may prove the means to restore the force of the circulation until reaction can be established by other measures.

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* Ueber Sublimat-intoxication bei Laparotomien. Centralblatt f. Chirurgie, 1886, No. 22.

Weir* suggests the administration of a hypodermatic injection of 1-100 to 1-80 of a grain of atropia and a large rectal enema of brandy before the anæsthesia for the purpose of increasing the force of the heart's action. During the operation the peripheral circulation is best kept up by placing the patient on a rubber bed, filled with hot water, and in the absence of such a contrivance by applying to the extremities rubber bags or bottles filled with hot water.

b. *Anæsthesia.*—A number of American surgeons have recently expressed a preference for chloroform to ether as an anæsthetic in abdominal operations, as it is less likely to produce vomiting before, during and after the operation. Another serious objection to the use of ether, especially in persons advanced in years, is the frequency with which bronchitis is produced when this anæsthetic is exclusively used. The use of chloroform, however, is also not free from objection. The depressing effect of this anæsthetic on the action of the heart is well known, and as the force of the circulation is almost without exception seriously impaired in these cases, its prolonged use might result in dangerous consequences. The best course to pursue is to follow the use of chloroform by ether. The retching and bronchorrhœa are prevented by placing the patient first under the influence of chloroform and the deleterious effects of the prolonged use of this agent are avoided by keeping up the narcosis during the operation with ether. From the time the first incision is made until the abdominal wound is closed the patient must be kept profoundly under the influence of the anæsthetic, inasmuch as any interruption will cause an unnecessary delay in the operation and may result in complications which are not easily remedied. Irrigation of the stomach should always procede the administration of the anæsthetic, as evacuation of the stomach by preventing vomiting will guard against the entrance of foreign material into the larynx and trachea, which might produce asphyxia during the narcosis or pneumonia later.

c. *Incision.*—Differences of opinion still exist among surgeons as to the size and location of the abdominal incision. The advocates of exventration argue in favor of a long incision through the median line. Kümmell advises that it should be carried from the ensiform cartilage to the pubes for the purpose of affording free access to every part of the abdominal cavity. While, on the other hand, a number of distinguished surgeons, among them Madelung, Czerny and Obalinski are in favor of a small incision. Polaillon* is strongly in favor of a lateral incision in opening the abdomen for the relief of intestinal obstruction in all cases where the seat of obstruction can be reached more directly by such incision. He also claims that in cases where extensive meteorismus is present the distended intestines are more prone to prolapse and are more difficult to return through a median than a lateral incision. He thinks that this is due to a lesser degree of intra-abdominal pressure in the iliac than the middle abdominal region, and that in the former the muscular fibres keep the margins of the wound in contact. He opens the abdomen in the ilio-inguinal region by an incision parallel with the fibres of the external oblique muscle, and if occasion requires, it can be made sufficiently large to permit exploration of the abdomen by the introduction of the whole hand. In lateral laparotomy exploration is less easy, but this operation is indicated in all cases of localized obstruction, circumscribed adhesion, or when any symptoms render it probable that the obstruction exists in one or the other side of the abdominal cavity. In case a distinct swelling, the probable cause of the obstruction can be detected in the ileo-cæcal region, the ascending or descending colon, as will probably be the case in ileo-cæcal and colic invagination, volvulus of the sigmoid flexure, tumors of the cæcum and colon, the incision should be made over the most prominent part of the swelling, as such a course affords the most ready access to the seat of obstruction and greatly facilitates the operative procedures which may become necessary. In reference to these points J. Greig Smith regards it as only less than a surgical calamity to perform median laparotomy for obstruction in the colon, since in the majority of cases it must, he says, be supplemented by a transverse or lumbar incision.

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* On the Technique of the Operations for the Relief of Intestinal Obstruction. The Medical Record, Feb. 2, 1888.

In all other forms of intestinal obstruction and in all cases where it is found impossible to ascertain the nature and location of the obstruction the incision should be made through the median line. Not much time should be consumed in making the external incision. With successive strokes of a sharp scalpel the tissues are rapidly divided until the subperitoneal layer of fat is reached. This is picked up and nipped between two toothed forceps; when the peritoneum comes into view it is seized and divided in a similar manner. The incision is then enlarged as circumstances may require by introducing the left index and middle finger into the peritoneal cavity and dividing the tissues with a blunt-pointed bistoury or scalpel between them. Hæmorrhage is arrested as it occurs by applying hæmostatic forceps to the bleeding points which in most instances obviates the application of ligatures. In reference to the size of the incision this will vary in accordance with the difficulties which are encountered in locating the seat of obstruction and in removing the cause, or causes, which have produced the occlusion. With few, if any exceptions, it must be large enough to admit the introduction of the whole hand. As a rule it may be stated that the ease in diagnosis increases with the size of the incision, and the danger which attends searching in the dark for the seat of obstruction more than overbalances the slight increase of risk incident to a large incision. Intra-abdominal manual exploration through a small incision is, in most instances, an unreliable diagnostic measure, as the cause of obstruction may be of such a character as entirely to elude such method of examination. It is a well known fact that the location of the seat of obstruction even in the post-mortem room after a full abdominal section has sometimes been found a difficult task. A large incision shortens the operation by facilitating the intra-abdominal examination and the operative treatment of the obstruction and the immediate risks of the operation are diminished in proportion to the shortening of the time required in its performance.

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* Gazette Médicale de Paris, April 25, 1885.

d. Intra-abdominal Examination.—The first and most important object of the external incision is to enable the surgeon to make a satisfactory intra-abdominal examination. Unless a positive diagnosis has been made beforehand the first incision is an exploratory one. Exploration of the abdomen for the purpose of locating the obstruction and ascertaining its nature is a more difficult procedure than in cases of abdominal tumors, and on this account the first or exploratory incision must be made at least large enough to enable the surgeon to combine ocular inspection with manual exploration.

Smith says:* "The best guide to the seat of operation is not manual exploration, but visual examination, assisted, if necessary, by extrusion of bowel."

The surgeon must bear in mind that in nine out of ten cases of intestinal obstruction the cause is located in the lower portion of the abdominal cavity, below the umbilicus, and that in the great majority of these cases it will be found either in the right or left inguinal region.

Bryant lays down the rule that in all abdominal operations for intestinal obstruction, when the seat of obstruction cannot be readily found, the surgeon should find the cæcum, since it is from it that he will obtain his best guide. If this be distended, he will at once know that the cause of obstruction is below, if it be found collapsed, or not tense, the obstruction must be higher up. The naked eye appearances of the intestine that presents itself in the incision will serve a useful purpose in deciding whether it belongs to the part of intestine above or below the seat of obstruction. In all cases of intestinal obstruction the bowel above the seat of obstruction is dilated and congested, while below the obstruction it is empty, pale and contracted. The contents of the presenting loop, if distended, will also indicate whether it is near or distant from the obstruction ; if near, it will probably contain fluid fæces and gas, if distant only gas. If the obstruction is located in the lower portion of the small intestine, or in any portion of the colon, without exception, a distended loop above the obstruction presents itself in the wound.

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* The British Medical Journal, August 29, 1885.

Fowler* has called attention to the fact that in all forms of intestinal obstruction the empty contracted portion of the intestine corresponding to the part below the obstruction is always found in the pelvis, and that it may be most easily reached towards the right side. He explains this on the supposition that during the violent and continued peristalsis and gradual distension of the bowel above the obstruction, the smaller and less active portion of bowel below, after expelling its contents, is forced downwards into the pelvis, whilst the distended, and therefore specifically lighter, portions rise to the surface. The pelvis also is too small to hold a distended loop. If the seat of obstruction cannot be readily found by manual exploration of the regions where it occurs most frequently two methods of further examination present themselves. The presenting bowel is drawn forward into the wound and systematically examined step by step as it glides through the fingers of the surgeon who replaces the loops as they are examined. This method of examination is only safe and practicable where the distension of the intestines is moderate, and the intra-abdominal pressure not extensive, so that loop after loop can be drawn forward, examined and returned without injury to the intestine. If this method of examination is selected it would be advisable to secure the portion of intestine first examined near the wound by passing a strip of gauze through its mesentery, so that in case the obstruction is not found in one direction the examination in the opposite direction can be made without passing the portion already examined again through the operator's hands. Mikulicz attains the same object by an assistant holding the first knuckle that appears against one of the angles of the wound while the operator examines and returns immediately coil after coil until the obstruction is found. During the examination prolapse of the intestines is prevented by an assistant who guards the opening with an antiseptic compress, and thus as inspection is progressing, unnecessary exposure of the intestines is prevented. For the purpose of avoiding exventration and its evil consequences in cases of intestinal obstruction with great distension of the abdomen, Madelung* has recently described a new method of dealing with the distended intestines. He makes a comparatively small incision through the median line and brings the first distended knuckle of intestine that presents itself into the wound and by passing two fixation ligatures through the mesentery near the gut and making traction upon them draws it forward sufficiently far until both limbs of the loop can be ligated with a strip of antiseptic gauze at a point corresponding to the external surface of the wound. The patient is now placed on his side and the prolapsed loop is incised over the convex surface and its contents evacuated. The gauze ligature is slowly loosened so as to prevent flooding of the wound with intestinal contents by too forcible escape of the fluid contents. When the spontaneous escape ceases a Nélaton's catheter is introduced into the incised bowel for the purpose of facilitating the escape of intestinal contents. Fifteen minutes are spent in efforts aimed at evacuation of the distended paretic intestine during which time anæsthesia is suspended in order to effect still further evacuation of the bowel above the seat of obstruction by the contraction of the abdominal muscles. After all discharge has ceased the visceral wound is cleansed and sutured and the ligatures on each side of the wound are tied so as to prevent undue tension upon the sutures after the gut has been replaced. The ligatures are left hanging out of the wound to serve as guides to the incised part of the gut after the completion of the intra-abdominal examination. The abdominal incision is now enlarged and the intestine drawn forward and careful search made for the obstruction. If this is not found the incised loop of bowel is brought into the wound, the sutures of the visceral wound and the two ligatures removed, and an artificial anus established by stitching the intestinal wound to the margins of the external wound, and the portion which is not required for this purpose is sutured. While Madelung's procedure cannot fail in facilitating exploration of the abdomen by diminishing intra-abdominal pressure it is questionable if the room thus gained is a sufficient recompense for the time lost and the additional risks incident to an intestinal wound in a place where it is not required. If a laparotomy is decided upon in the treatment of an intestinal obstruction it is made for the distinct purpose of finding and removing the obstruction, hence if the patient's strength is such as to warrant this treatment at all, the surgeon should not close the abdomen with the principal object of the operation unaccomplished. How difficult it is to find the obstruction in some cases is well shown by Madelung, who in several cases where the seat of obstruction could not be located during life requested the pathologist when he made the post-mortems to locate the obstruction by introducing his hand through an incision, allowing him from ten to twenty minutes for the exploration ; in every instance he failed to find or locate the obstruction within the specified time. Where the ordinary methods of examination through an incision large enough to permit the introduction of the hand prove themselves inadequate in locating the obstruction, after a search of from ten to twenty minutes it is useless and unwise to persist in pursuing the same course. Such cases should be dealt with by resorting to exventration. This method of exploration was first suggested by Harber in 1872, and practised by Kümmel* in 1885. The large incision which he advocates is necessarily followed by prolapse of the distended intestine and enables the surgeon to examine rapidly and accurately every portion of the intestinal canal with a view of locating the obstruction with little or no risk of inflicting injury during the examination. The greatest objection that has been urged against it is that it is sometimes exceedingly difficult to replace the intestines even after the cause of obstruction has been removed, as the paretic intestines are slow in regaining their normal peristaltic action, and that during the attempts at replacement the intestines are often injured. The proper way to effect replacement is to follow Kümmell's advice and instead of making direct compression to resort to protection of the intestines by covering the whole mass with a warm moist aseptic compress, the margins of which are tucked in under the abdominal incision ; in this way the bowels are protected against the injurious effects of irregular direct pressure and are guided back into the abdominal cavity as the wound is closed by tying the sutures already in place from above downwards. If uniform, diffuse, gentle pressure fails in replacing the intestines then the margins of the abdominal incision should be lifted with blunt hooks, an expedient which renders material aid in effecting replacement. Should the obstacles be so great as to frustrate all attempts at

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* The Lancet, June 30, 1883.

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* Zur Frage der operativen Behandlung der inneren Darmeinklemmungen. Archiv f. Klin. Chirurgie, B. XXXVI, p. 283.

* Ueber Laparotomie bei innerer Darmeinklemmung. Deutsche Med. Wochenschirft, 1886, No. 12.

replacement it is better to resort to incision and evacuation of the most distended portion of the prolapsed bowel which can be done with greater safety and more marked effect than by the plan devised by Madelung. This is well illustrated by a case that recently came under my observation which I will report in brief.

The patient was a woman forty-eight years of age, the mother of eight children, the last being an infant ten months old. She stated that she had suffered during the last year from constipation, but had always been promptly relieved by cathartics. Ten days before her admission into the Milwaukee Hospital, April 18, 1888, symptoms of acute intestinal obstruction appeared which increased in intensity until fæcal vomiting supervened the day before she came under my observation. She had been treated by high injections and irrigation of the stomach, the former without any effect, the latter afforded great relief. The patient was well nourished and her general appearance gave rise to no suspicion of malignant disease in any of the organs. She had passed nothing per viam naturalis since she was taken ill, and the retching and vomiting were persistent. The abdomen was uniformly and enormously distended ; upon the surface of the abdominal wall the outlines of some distended coils of intestine could be distinctly outlined The tympanitic distension of the abdomen interfered with respiration, the respiratory movements being shallow and rapid, lips cyanosed and extremities cold. Examination per vaginam and rectum revealed nothing as to the seat and nature of the obstruction. Percussion and palpation of the abdomen yielded the same negative results. Laparotomy was performed under the most careful antiseptic precautions. The stomach was irrigated and chloroform used as an anæsthetic. The operation was performed with the patient upon a rubber bed filled with hot water. The first incision was made half way between the umbilicus and pubes and large enough to permit the introduction of the hand. As soon as the peritoneal cavity was opened a loop of small intestine distended to three times its natural size and intensely congested presented itself. This was pushed aside and similar loops made their appearance. I now introduced my hand and found that the cæcum and entire colon were also enormously distended which satisfied me that the obstruction must be located low down in the colon, or the upper part of the rectum ; but the most careful attempts by manual exploration failed in furnishing any clue as to the location or nature of the obstruction. The incision was enlarged upwards an inch above the umbilicus and downwards to the pubes for the purpose of effecting complete exventration. Two assistants caught the intestines as they prolapsed in warm moist aseptic compresses, and as the abdominal cavity was nearly empty I could explore with ease the sigmoid flexure, which I had reason to believe was the seat of the obstruction ; as this part of the colon was also greatly distended, I had to proceed lower down with my exploration and finally found a circular carcinoma below the sigmoid flexure in the pelvic cavity near the junction of the colon with the rectum. As resection in this locality was impossible and for the same anatomical reasons an anastomosis could likewise not be made, I was forced to establish an artificial anus. In examining the colon with the view of the best locality for making a colostomy, I found that the enormous dilatation of this part of the intestine had resulted in such an elongation as to force the transverse colon in a downward direction nearly as far as the brim of the pelvis. I made an incision in the left inguinal region above Poupart's ligament two inches in length and sutured the parietal peritoneum to the skin. Into this incision a loop of the displaced transverse colon was pushed by the hand within the abdomen and fixed by a number of sutures. When this was done I attempted to replace the intestines, but after trying all the ordinary devices I had to abandon the attempt. The patient was now placed on her side, and one of the most distended loops was grasped, held over a basin, and punctured with a trocar, while the remaining intestine remained covered with the warm compresses. As the escape of gas and fluid fæces through the cannula was very slow, an incision an inch and a half in length was made in the gut. As the intestine did not contract the escape of contents was very slow, and I had to resort to pouring out of the contents, as it were, by seizing the gut several feet above and below the incision and elevating it, a large quantity of fluid fæces was literally poured out. When no further evacuation could be effected the visceral wound was closed by the continued suture, and after the loop was thoroughly disinfected the bowels were returned without further difficulty. The abdominal incision was closed in the usual way, only that I added two tension sutures as a matter of precaution. After the abdominal wound was closed and dressed, the colon that had been stitched into the inguinal wound was incised and the margins of the incision separately stitched to the sides of the external wound. A considerable quantity of gas and fluid fæces escaped. The vomiting ceased after the operation and the patient rallied under the effects of stimulants. The abdominal distension had diminished greatly the next day, and disappeared almost completely on the second day. The patient's general condition continued to improve until the tenth day after the operation when symptoms of collapse set in which persisted until she died on the following day. The post-mortem showed that the median incision had healed with the exception of the skin, and that the artificial anus had served as a perfect outlet to the intestinal contents. Small intestines restored to their normal size, and incision healed, the fine silk suture being completely embedded. The cause of the recent diffuse septic peritonitis was traced to perforation of a small abscess behind the carcinoma. The constriction caused by the carcinoma had reduced the lumen of the bowel so much that it was only permeable to the tip of the little finger.

I shall refer again to the subject of chronic causes giving rise to acute obstruction. This case also illustrates the importance of establishing the artificial anus, when such a procedure cannot be avoided, not in the laparotomy wound, but in the right or left inguinal region. When exventration is practised it is essential to furnish the prolapsed and dilated intestine with an artificial covering which should act as nearly as possible as a substitute for the abdominal parietes. This is best accomplished with warm compresses in the hands of one or two reliable assistants. After the surgeon has found the obstruction it becomes necessary to demonstrate the permeability of the remaining portion of the intestinal canal, as it has happened that after a successful removal of an obstruction that patients have died because a second obstruction was overlooked. Of course in such cases the search for additional obstructions must be extended below the obstruction which has been found and removed. An infalliable test for ascertaining the permeability of the remaining portion of the intestinal canal is furnished by rectal insufflation of hydrogen gas. In cases where after exventration it is not possible to find the obstruction by examination of the distended portion of the intestine, the contracted empty portion below the obstruction can be brought into sight by the same means and a search for the obstruction made from below upwards by examining the bowel as it becomes inflated until the seat of obstruction is reached.

Operative Treatment of the Obstruction.

I. *Intestinal Anastomosis.*

What shall be done if the obstruction cannot be found after all diagnostic resources have been exhausted? Shall we establish an artificial anus and leave the patient to the inevitable fate of remaining a sufferer from this loathsome condition the balance of his lifetime should he recover from the operation? Under such circumstances the surgeon assumes a great responsibility in establishing an artificial anus high up in the intestinal canal, even as far as the immediate effects of the operation are concerned. The paretic bowel below the seat of the artificial outlet unable to empty itself of its contents constitutes an immediate and remote source of danger, as it leaves that portion of the bowel between the new opening and the obstruction in the same condition as before the operation, and permanent exclusion of a considerable portion of the intestinal canal alone may subsequently destroy life by progressive marasmus. In such cases I should advise the following plan of treatment. The empty bowel below the seat of obstruction, if not already found, should be inflated with hydrogen gas per rectum and the highest portion of the inflated bowel drawn forward into the wound and two rubber bands passed through its mesentery about four inches apart and held in place by an assistant. The surgeon now locates as near as he can the lowest portion of the bowel on the obstructed side, which is also brought forward into the wound and similarly secured. The bowel on the proximal side is incised on the convex surface to the extent of an inch and a half; through this incision the contents are evacuated as far as possible, after which all the four rubber bands are tied and the bowel on the distal side incised in a similar manner. Into each of these incisions a decalcified perforated bone plate is inserted, and with the lateral suture armed with a round needle the margin of the wound on each side is transfixed. After the plates and sutures are in place the loops are thoroughly disinfected and the serous surfaces to the extent of the size of the plates are lightly scarified with the point of a needle, when the wounds are placed *vis a vis*, and the corresponding four threads tied together with sufficient firmness to secure perfect coaptation of the serous surfaces. The sutures are cut short and their ends buried as deeply as possible by pushing them in between the approximated bowels with a director or blunt scissors. A few superficial stitches of a continued suture will enhance the safety of the operation. In this manner an anastomosis is established with the exclusion of probably only a small portion of the intestinal tract. After uniting two intestines by approximation plates in the formation of an intestinal anastomosis it appears at first sight as though on the slightest distension of the intestines leakage of gas or fluid contents would take place between the serous surfaces. That this fear is unfounded I have satisfactorily proved by a number of experiments. The intestines of animals recently killed were used and an anastomosis made between the lower portion of the ileum and the colon. The colon was tied below the new opening and fluid forced into the ileum on the proximal side. The pressure was measured by a mercury gauge. It was found that no leakage occurred under a pressure of two pounds to the square inch continued for thirty seconds. As even in cases of great intestinal distension the pressure can never reach this degree; leakage from mechanical or physical causes will never take place from the new opening. The margins of the visceral wounds act like valves, and when the serous surfaces are kept in contact by the plates prevent the escape of gas or fluids into the peritoneal cavity. The safety and practicability of this operation I have abundantly demonstrated by my experiments on animals and by a number of operations on the human subject. The operative treatment of the obstruction will depend upon the location and nature of the obstruction. If it is decided not to remove the obstruction either on account of its intrinsic harmless character, aside from its mechanical effect, or, on account of its extent, in which case the removal would be an imminent source of danger to life, or if after removal a recurrence in the near future appears inevitable, an anastomosis is established between the intestine above and below the obstruction by lateral apposition with decalcified perforated bone plates. By this operation the continuity of the intestinal canal is restored with permanent exclusion of the seat of obstruction. In cases of cicatricial stenosis as a cause of obstruction, intestinal anastomosis, for instance, would be a vastly more safe operation than resection and circular enterorrhaphy, and would secure equally well the restoration of the continuity of the intestinal canal. In cases of carcinoma of the intestine with extensive infiltration of the lymphatic glands a resection followed by circular enterorrhaphy must always constitute a hazardous procedure, and even if it proved successful an early recurrence of the disease would be inevitable. Under such circumstances it is advisable to establish in preference an intestinal anastomosis which will effectually exclude the cause of obstruction, alleviate suffering and prolong life. The opponents of laparotomy in cases of acute intestinal obstruction have urged as one of the principal reasons for their opposition that the dilated inflamed intestine above the obstruction is not in a condition to undergo reparative processes when the operation demands a solution of continuity in this part of the intestinal tract. Circular enterorrhaphy under such circumstances is a very dangerous procedure for two reasons: 1. It becomes necessary to unite bowel ends of unequal size. 2. The inflamed intestine has undergone textural changes illy adapted for suturing as the sutures readily cut through the softened tissues. A number of clinical observations have satisfied me that the failures which have attended circular enterorrhaphy in such cases are not due to a lack of healing capacity on part of the inflamed end of the bowel, but to the mechanical difficulties which are encountered in the approximation and retention of the bowel ends, and the danger of the cutting through or yielding of the sutures. I believe on the contrary that in case septic peritonitis does not exist, the vascularity of the bowel above the seat of obstruction constitutes a favorable condition for rapid union. To demonstrate the correctness of this assertion, I made the following experiments:

Experiment 1.—Dog, weight 14 lbs. The whole abdomen was shaved and thoroughly disinfected, and while the animal was under the influence of ether a small incision was made in the left iliac region, and a loop of intestine drawn forward and ligated with a band of iodoform gauze, the ligature being tied with sufficient firmness to cause complete occlusion, intestine returned and wound sutured. Seventy-three hours later the dog was again etherized and median laparotomy performed. Distended vascular loops of the intestine came into the wound, which were pushed aside and the hand introduced, which being passed towards the left inguinal region at once came in contact with the ligated portion which had formed adhesions to the parietal peritoneum and neighboring intestinal loops. The adhesions were separated and the ligated loop drawn out of the wound. Above the ligature the bowel was at least one and a half times larger than immediately below the seat of obstruction, very vascular and contained gas and fluid fæces. The degree of dilatation diminished from below upwards. The seat of obstruction was eight inches above the ileocæcal valve, and the gauze ligature was covered with a thick layer of plastic lymph. The obstruction was left and the continuity of the intestinal canal restored by an ileo-colostomy with perforated decalcified bone plates. The animal, which was not vigorous before the experiment was made, appeared much prostrated and died twenty-four hours after the operation. The necropsy showed that the bowel above the constriction had to a great extent recovered its normal size and color. The two intestines where anastomosis was made were firmly adherent, the groove between them corresponding to the length of the plates filled in with plastic lymph. New opening permeable; no leakage at point of operation under hydrostatic pressure. No peritonitis.

Experiment 2.—Dog, weight 24 lbs. Obstruction produced in a similar manner as in preceding experiment. Seventy-five hours later operative treatment of obstruction by laparotomy. The seat of obstruction was again readily found by manual exploration of the abdomen. Bowel above seat of constriction at least twice the normal size and highly congested. Peristaltic action sluggish, responding very slowly and imperfectly to mechanical irritation. Gauze band buried under a ring of plastic lymph, which bridge-like united the gut below and above the constriction. As the obstruction was located about the middle of the ileum an ileo-ileostomy by lateral apposition with decalcified perforated bone plates was made leaving the gauze band undisturbed. The incision into the bowel above the seat of obstruction showed that all the coats were thickened and softened, while below the obstruction only the mucous membrane was in a state of catarrhal inflammation. About eight inches of the bowel including the seat of constriction were excluded by the operation. The animal showed no signs of suffering or illness after the operation, and when killed after the expiration of twenty-one days was in excellent condition. During this time the appetite was good and fæcal evacuations normal. Gauze band completely encapsuled, and close to it an acute flexion of the bowel; excluded portions adherent along convex surface to each other; bowel above constriction about one-third larger than below. New opening admits the tips of two fingers.

Experiment 3.—Dog, weight 28 lbs. Laparotomy seven days after complete obstruction had been caused by ligation of small intestine with gauze band through a small wound in the left inguinal region. Tympanites moderate. Obstruction found sixteen inches above the ileo-cæcal region. Peristaltic action almost suspended in bowel above obstruction,—normal below. Intestine above the constriction dilated to twice its normal size, exceedingly vascular, containing solid fæcal masses, fluid fæces and gas; below, empty, contracted and anæmic. Exclusion of six inches of the intestine at seat of obstruction and restoration of continuity of intestinal canal by ileo-ileostomy with decalcified perforated bone plates. After operation function of intestinal canal normal and appetite good. Killed eight days after operation; no peritonitis: adhesion of omentum to line of abdominal incision; gauze band completely covered by a plastic exudation; a number of adhesions between adjacent intestinal loops. Point of operation situated in the center of a horse-shoe shaped loop of intestine which was found to be the excluded portion. Intestine above obstruction about one-fourth larger in size than below. Excluded portion of bowel empty. At seat of anastomosis a mass of straw and hair had accumulated on proximal side. New opening large enough to admit two fingers.

Experiment 4.—Dog, weight 34 lbs. Complete obstruction of small intestines by ligation with gauze band through a small wound in the left iliac region. Operative treatment by laparotomy 120 hours later. This animal vomited several times shortly before the operation. Bowel at seat of obstruction adherent to adjacent intestines. Obstruction readily found and brought into the incision. Intestine above constriction twice its normal size, dark purple in color, tissues swollen and very much softened. Below constriction bowel empty, collapsed, pale, and only the mucous membrane in a state of catarrhal inflammation. The dilated bowel contained gas and fluid fæces. Peristaltic action in this part nearly suspended, the response to mechanical irritation being slow and imperfect. Below the obstruction, function of bowel unimpaired. As the occlusion was only four inches above the ileo-cæcal valve, it was found impossible to limit the anastomosis to the ileum consequently the continuity of the bowel was restored by an ileo-colostomy, uniting the ileum just above the obstruction with the colon above the cæcum, using the perforated approximation plates. The gauze band was left *in situ*. The animal showed no untoward symptoms after the operation, and was killed twenty-one days later. During this time appetite was good and intestinal function normal. A number of adhesions were found at site of operation between adjacent intestinal loops. Gauze band completely encysted. Some crude material, as straw, hair and fragments of bone was found on the proximal side of new opening. Anastomotic opening large enough to admit tips of two fingers; union between approximated portions of intestine so complete that it presented all around the appearance as though their peritoneal surfaces were continuous.

These experiments show conclusively that in acute obstruction even after seven days the bowel above the obstruction is capable of undergoing a rapid reparative process and that adhesive union takes place as early, if not earlier than, in operations upon a normal intestine. The experiments likewise prove the greater safety of anastomosis by lateral apposition with decalcified perforated bone plates than of resection and circular enterorrhaphy in restoring the continuity of the intestinal canal. Anastomosis, after resection for intestinal obstruction, can be made in the same manner between the proximal and distal part after the resected ends have been closed by invagination and a few stitches of the continued suture as when the obstruction is not resected but excluded.

In cases of congenital atresia of the small intestines most frequently met with in the upper portion, anastomosis should always take the place of circular resection, as the operation can be done in less than twenty minutes, an exceedingly important matter as far as the immediate effects of the operation is concerned in infants, at the most only, a few days old. In cases where such a congenital defect is suspected the abdomen should be opened in the median line, being careful not to cut through the umbilicus, when the seat of obstruction can be readily and rapidly located by inflation of the stomach and rectum with hydrogen gas. It is necessary to inflate from both directions, as in some cases the atresia is multiple. In cases of cicatricial stenosis of the pylorus a gastro-enterostomy by lateral apposition with approximation plates is a safer operation than resection, or the procedures recommended by Loretta and Mikulicz, while the functional result is equally, if not more, satisfactory. In carcinoma of the pylorus, where resection is contra-indicated on account of the extent of the disease, or its extension to neighboring organs, or because glandular infection has taken place, suffering can be diminished and life prolonged by making a gastro-enterostomy, substituting for the tedious double suturing as advised by Wölfler the perforated approximation plates. During the last year I have made four such operations and with such satisfactory results so far as the operation is concerned that I am induced to report them in this connection with the hope that others may give this method of operating a trial in similar cases. I have made it a rule that the patient should abstain from taking food by the stomach for at least twenty-four hours before the operation, and rely for a few days, at least, entirely upon rectal alimentation, allowing by the mouth only pieces of ice to quench thirst. The operations were performed as follows: The evening before the operation the stomach was washed out by the syphon tube and again just before the anæsthetic was administered. For the last irrigation a five per cent. solution of salicylate of soda was used. In all of these cases the incision was made through the median line and extended from near the ensiform cartilage to the umbilicus. The opening in the stomach was made parallel to the long axis of the organ and at least an inch and a half distant from the margin of the tumor. A continued suture of fine silk was applied around the whole circumference of the opening both for the purpose of arresting hæmorrhage and preventing bulging of the mucous membrane. In the intestine the opening was made between two rubber ligatures so as to prevent any extravasation of intestinal contents and the margins of the wound were sutured in a similar manner. The opening in the intestine was made first and the plate introduced and sutures adjusted and the loop retained in the lower angle of the wound, covered by a warm compress. The large curvature of the stomach near the pyloric orifice was then drawn sufficiently forward into the wound to make the incision and introduce the plate. When everything was ready for adjustment, the parts around the visceral wound were carefully disinfected, dried and the serous surface lightly scarified with an ordinary needle over a surface corresponding to the size of the plate; the new openings, (wounds) were then brought opposite each other and a fine silk suture, embracing only the serous and muscular coats, was applied behind the lower middle-plate-suture and tied; the middle lower suture was now tied, while an assistant approximated the two openings, the lateral sutures were next tied, and lastly the anterior middle. The sutures were all cut short and ends buried. During the tying of the sutures, it is necessary to exercise caution that the margins of the visceral wound are well embraced by the plates all around. As in these cases the weight of the intestine exerts considerable tension, I have taken the precaution in my two last cases to apply a superficial continuous suture anteriorly after tying the four sutures so as to approximate the serous surfaces over the anterior margins of the plates. The necessary preparations made, and with good assistance, the operation can be finished in from twenty to thirty minutes. Neither shock nor peritonitis was observed in any of the cases. Usually on the third day small quantities of peptonized milk and beef tea were given at short intervals and solid diet during the second week.

Case I.—Male, aged sixty-five. Symptoms of pyloric stenosis for one year. Emaciated to a skeleton; oedema of legs; unable to retain food of any kind for more than a few hours. The patient was so anæmic and prostrated that he was only partially anæsthetized. During the operation the pulse became almost imperceptible, and brandy had to be administered subcutaneously with lowering of head, and hot applications externally. An hour after the operation the pulse was stronger than before it was commenced. Rectal feeding; only slight rise in temperature on second day; no pain. On the third day small quantities of liquid food by the stomach. The heart's action gradually failed and the patient died of marasmus five days after the operation. The post-mortem revealed that the plates were still in situ, adhesions firm and opening patent. No peritonitis. In this case the carcinoma was circular and limited to the pylorus. Anastomosis just below the duodenum. The intense suffering had made the patient desperate, and although the nature of the disease and the probable outcome of the operation had been fully explained to him, he begged to have it done, with a perfect understanding that at best it would afford only temporary relief. I am quite confident that the operation did not shorten his life.

Case II.—Male, aged forty-seven. Duration of disease, eighteen months; obstinate vomiting; great emaciation and œdema of the legs. Contour of tumor could be readily mapped out by percussion and palpation. Tumor adherent to under surface of liver; enlargement of lymphatic glands. In this case the anastomosis was again made just below the duodenum. No untoward symptoms after operation. At the end of the first week solid food was allowed. No vomiting. At the end of the third week an abscess formed in the upper part of the healed incision, in the contents of which, the plate ligatures were found. A gastric fistula formed through which food escaped almost immediately after it was swallowed. This closed in less than two weeks. After which the patient improved in strength and gained in weight. He retained and digested all kinds of food. Improvement continued so that he was able to walk short distances and to take long drives. At the end of three months after the operation he commenced to fail and died two weeks later of progressive marasmus. Unfortunately no post-mortem could be obtained.

Case III.—Man, aged thirty-five. Symptoms of pyloric stenosis for six months. Tumor discovered four months ago rapidly increasing in size. Considerable amaciation and cachectic appearance. Tumor involves nearly one-third of anterior wall of stomach and the entire pylorus. Glands of omentum infiltrated. The first loop of intestine which came within reach was united with the anterior wall of stomach in the usual manner. Sutures of abdominal wound removed on the eighth day. Until this time no untoward symptoms, although the patient had taken liquid food for several days. The day following obstinate vomiting occurred; the plates, very much softened and greatly reduced in size, were ejected. The stomach was repeatedly irrigated, but vomiting continued until the patient died three weeks after the operation. Post-mortem: Abdominal incision united throughout; omentum, stomach and intestines adherent to abdominal incision. Anastomosis perfect at a point eight feet below pylorus. Intestine between pylorus and artificial opening enormously distended. As the opening was large enough to admit two fingers it was difficult to understand what had caused the obstruction. The pyloric orifice was large enough to admit the tip of index finger. Fluid could not be forced from the stomach into the bowel below the new opening. Injection through the duodenum was made with the same negative result. On close examination it was found that the intestine at the point of anastomosis, probably on account of the great length of the part between the stomach and the new opening, had become flexed at the point where it was attached to the stomach, and the two limbs were adherent to each other for four inches. This bending of the bowel had formed a spur opposite to the opening in the stomach by the apex of the concave side of the bowel, and this spur acting like a valve closed the opening in the distal part of the bowel when water was injected into the stomach or duodenum.

This case taught me that it is unsafe to follow the advice given by Luecke and others to seize the first presenting loop for the anastomosis, as by so doing, it is possible to grasp a loop of intestine which corresponds to the lower portion of the small intestines, as in this case, and if this is done we not only exclude permanently too great a portion of the intestinal canal from the processes of digestion and absorption, but a similarly unfortunate mechanical difficulty at the new opening may be created as has been described above.

Lauenstein recently reported a case of gastro-enterostomy where the post-mortem revealed that the new opening was made near the ileocæcal region. In making a gastro-enterostomy it is important for the reasons just cited to follow the advice of Hahn and search for the duodenum, which when found can be readily recognized by its short and fixed attachments, and to make the new opening in the upper part of the jejunum as near as possible to the duodenum.

Case IV.—Man, aged forty-three. Has complained of stomach difficulty for a year. During the last two months obstinate vomiting an hour or two after meals. Tumor as large as a child's fist; movable. Emaciation and marked anæmia; glandular infection behind the stomach. Anastomosis made just below the duodenum. Very little pain, and no other symptoms until the tenth day, when he vomited several times. Stomach washed out twice, four hours apart, and food by the stomach discontinued. No vomiting after this, and after two days a liquid diet ordered. At the end of the second week could digest all kinds of solid food which caused no distress. On the thirteenth day fragments of both plates were found in one of the stools. Patient has gained in flesh and presents a great deal better appearance at this time (four weeks), than before the operation.

These cases have satisfied me that gastro-enterostomy in cases of inoperable carcinomatous stenosis of the stomach is a safe and justifiable operation and should be more frequently resorted to, as it is the only resource which promises substantial relief, prolongs life and infuses new hope in a class of patients otherwise doomed to a speedy death without a ray of hope.

II. *Physiological Exclusion by Anastomosis.*

In some cases of intestinal obstruction the restoration of the continuity of the intestinal canal by resection and circular enterorrhaphy would necessitate the removal of several feet of the intestine where the cause of obstruction in itself constitutes no intrinsic source of danger, and where recovery would be more likely to take place by the substitution of anastomosis for resection. That resection of a number of feet of the small intestines is not always compatible with health is well illustrated by a case reported by Baum, in which he removed 137 ctm. in a woman forty years of age. The patient was suffering from strangulated femoral hernia. Taxis was only partially successful. On opening the sac an offensive fluid escaped, and a portion of the omentum was removed. Peritonitis followed and a swelling formed in the abdomen above the crural ring, which broke and a fæcal fistula formed ; rapid emaciation ensued, symptoms of strangulation made a laparotomy necessary. A mass of intestine was found twisted into a bunch which could not be unravelled, and as it was surrounded by an abscess it was resected and the ends united with sutures. Patient recovered from operation and improved for several weeks. Six months later progressive marasmus resulted in death. The autopsy revealed no other cause of death except marasmus from too extensive resection. In such a case I would propose that the twisted adherent intestinal coils, the cause of the obstruction, if they present no evidences of gangrene, should be left and permanently excluded from the fæcal circulation by making an anastomosis with approximation plates between the bowel leading to and from the obstructing mass. A case somewhat similar to Baum's, but under less favorable circumstances, came under my care during the last year where this plan of treatment was adopted.

Strangulated Hernia : Resection of Gangrenous portion : Additional Obstruction by a mass of adherent intestinal loops : Restoration of Continuity of Intestinal Canal by Anastomosis.—The patient was a brewer, thirty years of age, who had had an inguinal hernia for several years, but never wore a truss. On lifting a heavy weight the swelling became suddenly enlarged, followed by symptoms of acute strangulation. The attending physician overlooked the hernia and treated the patient for gastritis. Eight days after the attack he was admitted into the Milwaukee County Hospital. At this time symptoms of acute diffuse peritonitis were well marked. Pulse rapid and feeble ; extremities cold ; abdomen tympanitic and excessively tender on pressure. Stercoraceous vomiting. Hernia as large as a child's fist, skin covering it discolored and œdematous. It was plain enough that gangrene had occurred, and that in consequence of this peritonitis had developed. The patient was given $\frac{1}{120}$ of a grain of atropia hypodermatically before chloroform was administered. On opening the sac fæcal matter escaped and a large mass of discolored omentum presented itself. The sac was irrigated with a weak solution of sublimate, and the omentum drawn forward and wrapped in a small compress of gauze. The entire loop of intestine was gangrenous and perforated on the convex surface at its highest point. The parts were again irrigated before the inguinal canal was laid open by incision. The omentum was now drawn downward until a healthy portion was reached, when it was ligated in several parts and cut off. The intestine was separated from its attachments to the inguinal canal and the gangrenous part about eight inches in length excised after having previously guarded against fæcal extravasation by applying a rubber ligature on each side. Examination of the abdominal cavity at this time showed recent peritonitis. In drawing down the proximal end of the gut it was found that it was but little distended, hence search was made for an additional obstruction higher up, which was found in the shape of a mass of intestinal coils twisted in every conceivable shape and so firmly adherent that all attempts at unravelling had to be abandoned. The intestine above this point was enormously distended, showing that the bunch of adherent intestines had caused a second obstruction. Excision of three to four feet of intestine, under these circumstances, was not to be thought of as the patient would certainly have died on the table. Should I leave the cause of obstruction and establish an artificial anus on the proximal side? I decided to leave the obstruction and establish a communication between the intestine on the distal and proximal side of the obstruction. Both resected ends were closed by invagination and a few stitches of the continued suture. By lateral apposition with decalcified perforated bone plates an anastomosis was established between the distal collapsed end and the dilated bowel on the proximal side of the obstruction. Before the approximation sutures were tied the intestinal contents were evacuated as far as possible. The whole peritoneal cavity was flushed with sterilized water, carefully dried, drained, and the wound sutured. The toilette of the peritoneum was made with a sponge wrung out of a 1–2000 solution of sublimate. The hernial sac was excised and the stump fastened in the inguinal canal by the deep sutures used in closing the external wound. Duration of operation less than an hour. The patient rallied from the operation, but succumbed to the peritonitis at the end of twenty-four hours. Post-mortem: On removing the sutures the sac walls were found agglutinated by plastic lymph. Drainage tube surrounded by a thick layer of plastic lymph, and coils of intestine which completely shut out the abdominal cavity. Only about half of the omentum remained. The part of intestine where anastomosis was made was found in the pelvis lying against the concave surface of the sacrum, surrounded by numerous recent adhesions. The new opening was twelve inches above the ileo-cæcal valve; adhesion between the serous surfaces, held in approximation by the plates, was sufficiently firm to prevent leakage under strong hydrostatic pressure. Opening patent.

My experiments on animals related in the paper previously referred to have demonstrated that physiological exclusion of a certain portion of the intestinal tract is a less dangerous operation than excision. The appearances of the specimens also tend to prove that so long as any of the contents of the intestines reach the excluded portion, the peristaltic, or anti-peristaltic action in that part is effective in forcing it back into the active current of the fæcal circulation. If the excluded portion again becomes permeable it resumes its physiological function and again takes an active part in the processes of digestion and absorption; if the obstruction remains permanent it undergoes progressive atrophic changes.

III. *Laparo-Enterotomy.*

Incision of the bowel for the removal of obstruction during laparotomy is indicated when the obstruction is due to the presence of a foreign body, a concretion, an enterolith, or a pedunculated benign polypoid tumor. In the removal of a foreign body, a concretion, or an enterolith, not amenable to removal by submural crushing, or fragmentation with a needle, the incision for extraction should not be made over the seat of impaction, as this part of the intestine has undergone changes unfavorable to the satisfactory healing of the visceral wound. It is much better in such cases to make the incision in a healthy part of the intestine an inch or two below the impaction, and then crush the foreign body by instruments introduced through the incision. The removal of a non-malignant pedunculated polypoid tumor is to be accomplished by making an incision on the convex surface of the bowel large enough to admit of dragging the tumor through it, after which the base of the pedicle is transfixed by a double ligature and tied, the tumor cut off and the wound closed in the usual manner.

IV. *Enterectomy.*

Enterectomy is indicated when the obstruction is due to a malignant tumor if it is possible to remove the disease completely, also for the removal of benign tumors which cannot be excised by enterotomy, and in all cases where gangrene has been caused by constriction, compression or over-distension. Carcinomatous stenosis is met with most frequently in the large intestines, while the causes which result in gangrene are most common above the ileo-cæcal valve. For malignant disease resection should be done if the entire tumor and all infected glands can be removed completely and with safety. Even, if on account of loss of substance circular enterorrhaphy cannot be made in such cases, the continuity of the intestinal canal can be restored by lateral implantation, or by lateral opposition with decalcified bone discs. Immediate circular enterorrhaphy after resection for intestinal obstruction has always been attended by a great mortality for reasons mentioned elsewhere. In a series of thirty-five resections of the large intestines which Weir collected when symptoms of obstruction indicated the operation the mortality amounted to one hundred per cent. Reichel* has also shown that resection of the small intestines for conditions giving rise to obstruction, gave a mortality of 75 per cent., whereas in secondary resection for an artificial anus the mortality is reduced to 37 per cent., a statement which is supported by Makins† in his report of 15 deaths, in 39 resections for artificial anus. If after the resection is made, a primary circular enterorrhaphy is not made, Hahn recommends, so as to preserve the advantages of a clean wound and yet to allow the escape of fæces, that the intestine should be closed tightly around a rubber tube, which is left projecting some distance for this purpose. In the removal of a tumor of the cæcum with partial resection of the intestinal wall it may be advisable to follow the example of Porter,‡ in restoring the continuity of the intestinal canal by suturing. In his case a part of the circumference of the cæcum including a portion of the ileo-cæcal valve was resected for the cure of a fæcal fistula. The wound was closed by slitting up a portion of the ileum from the seat of resection and uniting the margins of this wound with the resected surface of the cæcum. The patient recovered. In cases where the lumina do not correspond it is advisable to follow the suggestion first made by Wehr in performing pylorectomy, viz : to cut the end of the narrower part of the bowel not transversely, but sufficiently oblique so that the circumference of the oblong opening will correspond to the lumen of the larger end of the bowel. The obliquity should always be made at the expense of the convex portion of the bowel, so as to interfere as little as possible with the vascular supply from the mesenteric side. Madelung in resecting the bowel makes his incisions somewhat obliquely in the same direction for the purpose of guarding more affectively against gangrene on the convex side of the bowel after circular enterorrhaphy. In such extensive resection of the colon where the possibility of circular suturing is precluded on account of the impossibility of approximating the cut ends, an artificial anus should never be established, as no subsequent treatment could restore the continuity of the intestinal canal. Two such cases were recently reported by Hahn. It is possible that, in the future, experimental research will prove the practicability of restoring such defects by a plastic operation consisting of transplantation of a corresponding portion of the small intestines between the separated ends, a procedure which would necessitate circular suturing—at three different points. Until it has been shown that some such plan is feasible the surgeon must content himself in establishing an anastomosis between the proximal and distal ends by lateral apposition with decalcified perforated bone plates. The latter procedure offers all the advantages to be derived from approximation and keeping in uninterrupted coaptation a large serous surface with immobilization of the parts it is intended to unite during the process of repair. In circumscribed gangrene, due to decubitus and involving not more than one-half of the circumference of the bowel, affecting its lateral or convex surfaces, such as is caused by constriction by a narrow band, resection is not necessary. After the constriction has been removed, the gangrenous spot is turned inward and is covered by suturing the adjacent healthy margins of the bowel over it. The serous surfaces unite rapidly so that perforation during the separation of the gangrenous part is prevented by union of the serous surfaces over it. When a whole loop or a number of loops of the intestine present evidences of gangrene from constriction the indications for resection are clear as affording the only possible chance of preventing death from sepsis or perforation. Unfortunately in such cases septic peritonitis has usually set in before the operation is performed, and it becomes necessary after the resection has been made and the continuity of the intestinal canal restored by approximation plates to treat the peritonitis by flushing the abdominal cavity with sterilized water and disinfection with some mild antiseptic, as a one-third per cent. solution of salicylic acid as advised by Mikulicz. Drainage in such cases becomes a necessity.

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* Kasuistische Beiträge zur cirkulären Darmresektion und Darmnaht. Deutsche Zeitschrift f. Chirurgie, B. XIX, Heft 2 u 3.

† Med. Chir. Transactions, vol. lxvi.

‡ Excision of a portion of Intestine, including Part of the Ileo-cæcal valve, for the Cure of Fæcal Fistula in right Groin. Boston Med. and Surg. Journal, May 15, 1884.

V. *Direct Treatment of Obstruction in Strangulation by a Band or Diverticulum, Flexion or Adhesion, of the Intestines.*

The most favorable cases of intestinal obstruction for laparotomy are those where the obstruction is due to constriction from a narrow ligamentous band. The history of such cases usually points to an antecedent attack of localized peritonitis. One or more of the adhesions during the course of time are drawn out into a band under which the intestine is caught, and strangulation takes place in the same manner as in strangulated hernia. These are the cases of intestinal obstruction which, if left alone, almost without exception result in death; if submitted to an early operation they are cured by one stroke of the scissors. If the strangulated loop presents no evidences of gangrene, and no signs of decubitus are found at the point of compression, the strangulation is relieved by cutting the band, and for the purpose of preventing a recurrence of the strangulation from the same cause it is necessary to trace the band to its points of fixation and resect it between two ligatures. A diverticulum of the small intestines, remnants of the vessels of the vitelline duct, or the appendix vermiformis have often been found as a cause of constriction when the free extremity of these structures had become adherent to some fixed point, and it is always necessary to make a close examination of a constricting band before resorting to cutting instruments, as a mistake in recognizing the true anatomical character of the obstructing cause might lead to serious results. A narrow appendix may be tied and resected the same as a ligamentous band, but when the obstruction is caused by a diverticulum greater care must be exercised in removing the cause of obstruction. Many of the diverticula which have been met with as a cause of obstruction were nearly as large at their base as the intestine with which they were connected, and in such instances it would be unsafe to rely upon a ligature at the resected end in affecting permanent obliteration as cutting through of the ligature might be followed by perforation, and death from septic peritonitis a few days after the apparent recovery of the patient. The proximal end of such a resected diverticulum must be closed with the same care and in the same manner as the ends of the intestine after permanent interruption of its continuity by resection and restored to function by anastomosis. If the obstruction is found to be due to flexion the mechanical difficulty must be corrected by separating the adhesions, as the apex of the flexion is generally if not always adherent to some fixed point; after this has been done the proper shape and contour of the bowel should be restored and its permeability tested by pushing the contents beyond the flexed part if this can be done without meeting with resistance and if the condition of the intestinal walls at the site of flexion presents no serious textural changes the intestine is returned and the abdominal incision closed. As the concavity of the flexion is usually directed towards the mesenteric attachment the vascular disturbances are most marked on the convex surface of the bowel, and if gangrene or perforation has taken place it is found at this point. In either of these events it would become necessary to liberate the intestine by separating the adhesions and then resort to a "V" shaped excision on the convex side of the intestine. The portion to be excised must be of sufficient size to include the diseased tissue and to enable the surgeon to rectify the malposition after suturing. Immobilization of a considerable portion of the intestinal canal by a large blood clot and extensive parietal and visceral adhesions may give rise to symptoms of intestinal obstruction. When intra-abdominal hæmorrhage is followed by a complexus of symptoms indicative of the presence of intestinal obstruction, the abdomen should be opened and the coagulated blood removed by sponging and flushing of the peritoneal cavity with sterilized water and the recurrence of the same condition prevented by arresting further hæmorrhage. A form of visceral adhesions between coils of intestines massed into a bunch has already been described as a cause of intestinal obstruction. If this condition has lasted for several days and the adhesions have become firm, it is absolutely impossible to unravel the gut without running the risk of inflicting numberless and perhaps irreparable injuries. In such instances excision of the mass, followed by circular enterorrhaphy, or anastomosis between the intestine above and below the obstruction, as previously described, present themselves as the most appropriate methods of treatment. Each of these operations is applicable to special cases and adapted to meet particular indications. Thus if any of the embedded coils should present indications of incipient gangrene resection must be done. If no such textural changes are present intestinal anastomosis should be preferred as by it the obstruction is removed and the portion temporarily excluded, after subsidence of the inflammation and absorption of the adhesions may again become permeable and resume its physiological function. Circumscribed parietal adhesions, as a cause of intestinal obstruction, are most frequently met with in the pelvis, and on account of the greater frequency of pelvic inflammation in the female occur more frequently in women than men. Pelvic intestinal adhesions produce obstruction in two distinctly different ways: 1. An adherent intestine becomes flexed or twisted by the peristaltic action of the free portions and obstruction results from sudden or gradual stenosis of the lumen of the bowel. 2. A portion of intestine becomes fixed at either end by adhesions and a loop is caught under it when obstruction is caused in the same manner as from ligamentous bands.

The only case of intestinal obstruction after ovariotomy which occurred in my practice was produced in this manner. The pedicle was tied and its surface cauterized. No untoward symptoms until at the end of the third week, when symptoms of intestinal obstruction appeared suddenly and increased in intensity in spite of irrigation of the stomach and high rectal injections. She died two weeks later. The post-mortem showed that a loop of the lower portion of the ileum had become adherent to the surface of the pedicle, and that the mesentery constituted the second fixed point; under this loop, another loop four inches in length had slipped from above downwards and had become incarcerated in this position. The intestine below the obstruction was perfectly empty, while above it, it was enormously dilated and exceedingly vascular as far as the duodenum.

Quite a number of similar cases have been reported by different operators. In old cases of pelveo-peritonitis and salpingitis the cause of a subsequent attack of intestinal obstruction is frequently traceable to intestinal adhesions and the formation of ligamentous bands. In the separation of such old adhesions the greatest care must be exercised not to tear the bowel, as both the parietal and visceral peritoneum may have been transformed into a cicatricial mass which it is not safe to separate by tearing. The separation must be done by careful dissection which for the sake of safety is done rather at the expense of the parietal than the visceral tissues. Defects of the peritoneum thus caused or made during other abdominal operations, should be covered either by suturing, by laying the omentum over it, or, if need be, by omental grafts to prevent a recurrence of such complication. The parietal peritoneum is so loosely attached almost everywhere that it yields sufficiently to cover a defect at least two inches in width by suturing and whenever this can be done it should not be neglected, as surfaces denuded of peritoneum are liable to become permanently adherent to adjacent abdominal viscera. If larger defects are to be covered the peritoneum can be cut in the shape of flaps which can be readily mobilized and sutured. When the omentum is within reach this should be utilized in covering the defect. During the last year I made a number of experiments on animals which demonstrate that when a piece of parietal peritoneum three to four inches square is removed and not restored in some of the above ways, permanent adhesions form between the denuded place and the organ that comes in contact with it. Another series of experiments which it would be too tedious to describe in full were made to show that peritoneal defects which cannot be restored by suturing or covering with the omentum can be treated successfully by transplantation of an omental or peritoneal graft. In some of the experiments I removed from each side of the abdominal wall at corresponding points a piece of peritoneum four inches square and transplanted the pieces to opposite points and sutured them to the margins of the wound with cat-gut. All of these experiments proved successful. Omental grafts answered the same purpose, and in only one instance did the graft fail to unite throughout, and here one of its margins projected into the median abdominal incision which did not unite by primary union. Infection of this margin led to gangrene of the graft and septic peritonitis.

VI. *Toilette of Peritoneal Cavity.*

If everything that has come into contact with the abdominal cavity during a laparotomy for intestinal obstruction has been rendered aseptic by the most scrupulous antiseptic precautions and the local conditions found have caused no infection and no soiling of the peritoneal cavity with intestinal contents has taken place during the operation, the abdominal cavity is aseptic after the operation and can be closed after the removal by gentle sponging of any blood that may have collected. Unnecessary exposure of the intestines should always be most carefully guarded against by compresses around the incision during intra-abdominal exploration, and by keeping the intestines constantly covered by warm compresses as long as they are outside the peritoneal cavity for the purpose of preventing infection by floating microbes and to guard against loss of heat during the operation. The case is, however, entirely different when the parts concerned in the obstruction have caused intra-peritoneal sepsis at the time the operation is undertaken, or when, during its performance in spite of all care to prevent it, the peritoneal cavity has become contaminated by fæcal extravasation. Under these circumstances the peritoneal cavity should be flushed with gallons of sterilized warm water in which one-third per cent. of salicylic acid has been dissolved. The end of the glass tube or rubber tubing of the fountain syringe should be held in different parts of the abdominal cavity, especially in the deepest portion of the pelvis and the lumbar regions so as to direct the current of the antiseptic solution out of and not into the peritoneal cavity. After the abdominal cavity has been cleansed by flushing it is dried by sponges wrung out of a 1-5000 solution of sublimate. In such cases drainage should never be omitted. The closure of the external incision when intra-abdominal pressure is excessive is greatly facilitated by covering the intestines with a napkin or thin compress of gauze which is tucked underneath the margins of the wound all around. The sutures should be all introduced before any of them are tied. When the sutures are all in place they are tied from above downwards. If tension is considerable it is necessary to add two or more button sutures, which are only passed down to, but not through, the peritoneum, and are removed as soon as the tympanites disappear.

VII. *After Treatment.*

Uniform equable support of the abdomen by strapping and bandages over the antiseptic absorbent dressing furnishes efficient support to the distended abdominal walls and the paretic intestines, and is not only grateful to the patient but is an important aid in relieving the distress due to distension and peristalsis. I have insisted that in all operations for intestinal obstruction efforts should be made to empty the bowel not only at the seat of obstruction, but as far as it can be done, as such immediate evacuation constitutes one of the elements of success. J. Greig Smith states distinctly that "No case of operation for intestinal obstruction is properly concluded until the distended bowels are relieved of their contents." One of the most favorable symptoms after a successful operation for intestinal obstruction is a spontaneous action of the bowels, as it not only proves the permeability of the intestinal canal, but is also an evidence that peristaltic action has been restored. The retention of fæcal material in the distended paretic intestines after operation for intestinal obstruction is a condition which not only retards recovery, but is in itself a grave source of danger. Through the sympathetic nerves the distended intestine exerts a most depressing effect on the cerebro-spinal centres, while the putrefactive changes which are constantly going on in the stagnant intestinal contents must be a constant source of intoxication, and at the same time the migration of septic micro-organisms through the paretic walls threaten life from septic peritonitis.

Mr. Tait has taught us the value of cathartics in the prevention of peritonitis after abdominal operations. Would it not be rational to follow his example in the after-treatment of operations for intestinal obstruction? I have repeatedly made the observation that the paretic intestine above the seat of obstruction will respond slowly, but surely to mechanical irritation, and it is only logical to conclude that the same effect would be produced by the administration of a brisk saline cathartic. *Dangerous as the use of cathartics necessarily must be before the obstruction is removed, so beneficial may their judicious employment be after the continuity of the intestinal canal has been restored by operative treatment.*

IV. Anatomico-Pathological Forms of Obstruction.

1. *Entero-lithiasis.*

a. Biliary calculi.—The term intestinal obstruction in the strict sense of the word is applied most appropriately to that form of obstruction where the lumen of the bowel is occupied and completely closed by a foreign body or an enterolith. A foreign body introduced into a healthy bowel, even if it completely fills its lumen, does not necessarily produce intestinal obstruction, as the healthy intestine is capable of dilatation to a sufficient extent to furnish an outlet to fluid intestinal contents between the wall of the bowel and the foreign body. The following experiments were made for the purpose of studying the effect of the presence of a foreign body of sufficient size to interfere with the passage of intestinal contents, and also with a view of ascertaining if the exclusion of peristaltic action of a certain segment of the intestine could produce intestinal obstruction. The operations were performed under strict antiseptic precautions, and the abdominal incision was always made through the linea alba. The animals were fed on the coarsest kind of food, and as a rule their appetites were not impaired by the operation.

Experiment No. 1.—Dog, weight 34 lbs. The ileum was drawn forward into the abdominal wound, and an incision made about an inch in length on the convex surface about twelve inches above the ileo-cæcal valve, and through this opening a stiff rubber tube four inches in length, and three-quarters of an inch in diameter, was inserted in a downward direction. The rubber tube distended the bowel so thoroughly as to produce a limited longitudinal rupture of the peritoneal coat. The tube was pushed forward as far as the ileo-cæcal valve, when the intestinal wound and the peritoneal rent were sutured. The visceral wound was covered with an omental graft which was of sufficient length to embrace the entire circumference of the intestine, and was fixed in its place by two catgut sutures, which were passed through the mesentery and both ends of the graft. The intestine was now thoroughly cleansed, dried, and returned, and the abdominal wound closed. The tube was passed per rectum in sixty hours. No symptoms of obstruction were observed during this time, and the animal remained in perfect health until killed twenty days after the operation. The intestinal wound was recognizable upon the external surface of the bowel by a ridge, which consisted plainly of a portion of the omental flap, the remaining portion had evidently disappeared by absorption, at least it had become invisible to the naked eye. The interior surface of the bowel along which the rubber tube had to pass on its way out of the body presented nothing abnormal.

Experiment No. 2.—Dog, weight 24 lbs. In this instance the incision in the bowel was made eighteen inches above the ileo-cæcal region, and instead of a rubber tube a glass tube three and three-quarters of an inch in length, and half an inch in diameter, was introduced, and pushed along the bowel until its distal end was within six inches of the ileo-cæcal valve. Omental graft over the visceral wound. No symptoms. Tube passed in sixty-eight hours. Dog killed fifty-seven days after operation. Intestinal canal throughout healthy. Omental graft had disappeared completely.

Experiment No. 3.—Dog, weight 62 lbs. Incision of bowel twelve inches above ileo-caecal region, and of sufficient size to permit the insertion of a glass tube five-eighths of an inch in diameter, and six inches in length, which was pushed in a downward direction to within an inch of the ileo-cæcal valve. The tube filled the lumen of the gut completely, but produced no tension in the walls. No symptoms. One month later the abdomen was again opened, and the tube was found in the descending colon. The abdomen was closed, and the tube was passed per rectum four days later.

In these experiments hollow tubes were used, and it might be claimed that intestinal obstruction was not produced because the fluid intestinal contents could pass through the lumen of the tube. The effect of the peristaltic action of the bowel in that portion occupied by the tube was certainly eliminated as far as the fæcal circulation is concerned, and yet no symptoms of obstruction during life were observed, and the post-mortem appearances indicated that no obstruction had existed during life. It is certainly surprising that the peristaltic action of the intestine should be able to force a rigid tube of such length and dimensions as were used in the last two experiments through the ileo-cæcal valve into the colon.

In the following experiments the foreign body which was introduced was of such a structure that in case it filled the entire lumen of the bowel it would of necessity produce intestinal obstruction, unless a space for the passage of intestinal contents would be created between the foreign body and the intestinal wall by dilatation of the bowel.

Experiment No. 4.—Dog, weight 34 lbs. Intestine was incised at the junction of the ileum with the jejunum and the barrel of a glass female syringe six inches in length and half an inch in diameter was inserted with the closed end in a downward direction. The animal never showed any untoward symptoms, and as the syringe was not found in the fæcal discharges the animal was killed six weeks later, when it was ascertained that it must have passed at some previous time through the normal outlet, as it could not be found, and the intestine presented throughout a normal appearance.

Experiment No. 5.—Dog, weight 60 lbs. In this experiment the incision in the bowel was made thirty inches above the ileo-cæcal valve, and through it was inserted with considerable force a glass female syringe 6½ inches long and three-quarters of an inch in diameter with a metal cap, which considerably increased its diameter at this point. The piston of the syringe projected one inch and a half from the cap. The perforated end of the syringe was directed downwards. Visceral wound protected with a circular omental graft. For the first few weeks the animal appeared to be in a good condition, and the fæcal discharges were normal. Later the apetite became impaired and the last few days obstinate constipation appeared. The dog was killed forty days after the insertion of the foreign body. At this time the syringe could be plainly felt through the abdominal wall. The syringe was found in the ascending colon, having passed through the ileo-cæcal valve. The ileo-cæcal region was distended, and the bowel at this point partially obstructed by a mass of straw, hair, fragments of bone, etc., for a distance of about ten inches. Above this point the bowel was considerably dilated and contained liquid fæcal matter. Several ulcerations were found in the portion of ileum traversed by the syringe. The lowest ulcer was about an inch and a half in length, and half an inch wide, reaching as far as the ileo-cæcal valve and apparently of recent date. The next ulcer, about one inch longer, but of the same width, was found six inches higher up. This ulcer presented a granulating surface and beginning cicatrization. The third point of ulceration was twelve inches above the ileo-cæcal valve, in an advanced stage of cicatrization. These ulcers were evidently of a traumatic origin and were undoubtedly caused by friction of the intestinal wall against the projecting point of the piston in the attempts of the bowel to propel the foreign body by increased peristaltic action. In this case the intestinal obstruction commenced with the accumulation of solid material on the proximal side of the syringe, being in reality not caused by the foreign body, but by the coprostasis. Had this latter condition not developed the foreign body would undoubtedly have been expelled spontaneously as in the former experiments. These experiments furnish positive proof that a foreign body of sufficient size to fill the entire lumen of a healthy intestine above the ileo-cæcal valve causes no obstruction, and that when obstruction takes place in such instances it is caused by tissue changes in the intestinal wall arising from prolonged contact with the foreign body. In reference to these points we shall consider the subject of entero-lithiasis as a cause of intestinal obstruction. Entero-lithiasis in man is due in the great majority of cases to the impaction of a gall-stone or the formation of an enterolith in the lumen of the bowel the nucleus of which is a gall-stone. It has been a disputed question in what way a gall-stone of sufficient size to give rise to obstruction could enter the intestinal canal. Rokitansky asserted that a calculus the size of a hen's egg may pass through the bile-ducts. It is now generally believed that, as a rule, at least, such large concretions can only escape from the gall-bladder by ulceration through its walls, or that a gall-stone of smaller size after it has passed through the bile-ducts subsequently becomes larger by the formation of concentric concretions during its retention in the intestinal canal. In reference to the frequency of this form of obstruction Leichtenstern has found that in 1541 cases of intestinal obstruction with different causes tabulated by himself, in 41 it was produced by gall-stones.

Wising* collected fifty-one cases of intestinal obstruction caused by the presence of a biliary calculus, with the result that in only 24 of them could the anatomical condition of the gall-bladder be ascertained. In 18 of these the post-mortem appearances showed that the calculus had entered the intestine from the gall-bladder by a process of ulceration, and only in three cases it appeared as though the calculus had passed through the common bile-duct. In 33 cases the place of obstruction was 12 times the jejunum, and 21 times the ileum. In the 21 cases where the calculus was impacted in the ileum the seat of obstruction in two was in the middle, in 6 in the upper half, and in 12 in the lower half of this portion of intestine. Icterus was observed only in 8 of the 51 cases. The prognosis is always very grave, as of the 51 cases 38 died. In 25 fatal cases, death occurred 14 times between the sixth and the eighth day, while in isolated cases it did not occur until from the ninth to the twenty-eighth day, and one patient died after two months from perforative peritonitis. Taking all cases of obstruction from gall-stones together, we can say that the seat of obstruction is located in the lower portion of the ileum in 50 per cent. of the cases. The upper part of the jejunum is the next most frequent site of obstruction, and in a few the gall-stone becomes impacted in the duodenum at the site where it has ulcerated through the walls of the gall-bladder and intestine. In 32 cases collected by Leichtenstern, the gall-stone occupied the duodenum and jejunum in 10 cases, middle of ileum in 5 cases, lower part of ileum in 17 cases. Treves is of the opinion that gall-stones causing intestinal obstruction ulcerate directly into the intestine. He had collected 48 cases of obstruction due to gall-stones. In the majority of cases direct evidence of ulceration between the gall-bladder and duodenum was to be obtained. The gall-bladder was entirely disorganized in a case in which the gall-stone was supposed to have traversed the biliary ducts. When impaction takes place high up in the intestinal tube tympanites may be entirely wanting and the symptoms point rather to the existence of pyloric stenosis than intestinal obstruction. The higher the location of the impaction the greater the probability that the calculus attained its size within the biliary passages, and that it entered the intestine by a process of ulceration. In some cases the communication between the gall-bladder and the duodenum remained at the time of death, showing that perforation had only recently taken place. Wising has reported such a case. The patient was a woman, 70 years of age, who had never suffered from biliary colic or jaundice. The attack of intestinal obstruction was acute, fæcal vomiting being an early symptom, slight icterus and little tympanites, death on the fifth day. At the necropsy a biliary calculus 7 ctm. in length and 10 ctm. in circumference was found firmly impacted in the ileum. The intestine on the proximal side was found greatly distended and of a color suggesting incipient gangrene, while the bowel below the obstruction was pale and contracted. Gall-bladder ulcerated and contracted by cicatricial tissue communicating with the duodenum by a perforation above the common bile-duct. A smaller communication was also found between the gall-bladder and the transverse colon. Shattock* mentions a case under the care of Dr. Bristowe, in which the remains of the gall-bladder, which was very small, communicated directly with the intestine.

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* Ueber Gallenstein ileus. Nord Med. Archiv., B. XVII, No. 18.

In some cases the pathological conditions within and around the gall-badder show evidences which go to prove that perforation had taken place long before the development of the intestinal obstruction. In such cases the gall-stone must have occupied the intestinal canal for a variable period of time without having given rise to obstruction, the intestinal contents passing between it and the intestinal wall in the same manner as in the experiments detailed above. In some cases the gall-stone becomes encysted and symptoms of obstruction are not produced until the size of the stone has increased by the addition of concentric layers of concretion. Harley† reported a case where a gall-stone became encysted in the duodenum. Woodbury‡ reports a case that came under the observation of Dr. T. H. Andrews, of a woman 60 years of age, who was suddenly attacked with symptoms of acute intestinal obstruction without having previously suffered from any disorder of the biliary passages. She died on the seventh day. A concretion the size of an English walnut was found firmly impacted in the upper portion of the jejunum. Upon section the concretion was seen to consist of a brown, friable, cortical substance, enveloping a dense, white crystalline body as large as a cherry, which was evidently cholesterine. It appears that in this case a small gall-stone which had passed through the bile-ducts without producing symptoms, was in some way retained high up in the intestine, and served as a nucleus for the formation of an enterolith of sufficient size to give rise to intestinal obstruction.

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* British Medical Journal, March 19, 1887.

† Path. Soc. Transactions, London. Vol. viii.

‡ Amer. Jour. Med. Sciences, January, 1880.

Barlow* reports the case of a woman 57 years of age who had symptoms of gall-stones for a year. She suddenly developed an acute intestinal obstruction from which she died. About the center of the ileum there was found a biliary calculus of the size of a walnut partially sacculated. In some rare cases the obstruction is caused by the retention of numerous calculi in a circumscribed portion of the bowel. Metcalfe† presented to the New York Pathological Society a specimen taken from a man 54 years of age, where the duodenum was occupied by numerous gall-stones in such a way as to give rise to complete obstruction. A calculus may attain great size before it becomes impacted. Smith‡ observed a case of acute intestinal obstruction which proved fatal on the fifth day, where the post-mortem revealed the cause to be a biliary calculus measuring 4½ by 2½ inches in circumference, which was found impacted in the jejunum 30 inches below the pyloric orifice of the stomach. Clark§ relates the case of a woman 58 years of age who died of acute intestinal obstruction where two large gall-stones were found impacted immediately above the ileocæcal valve, each of which was one inch in length and four inches in circumference, and together weighed 1¼ ounces. The stones were composed of cholesterine and coloring material of bile. The intestine was perforated at the seat of impaction and a number of small gall-stones were found in the peritoneal cavity. The biliary passages were dilated and thickened, but the gall-bladder appeared to be normal in size and structure and not adherent to the duodenum ; jaundice had never existed. Eight months previous to the last illness she had a similar attack of obstruction and at that time a firm tumor could be felt in the right hypochondriac region. This and the next case illustrate that the great danger of impaction of a gall-stone consists of textural changes of the intestine at the site of impaction. Meymott's* patient was a woman 47 years old, who died after a short illness, during which symptoms of intestinal obstruction were well marked. At the necropsy a gall-stone composed of cholesterine, and weighing 400 grains was found impacted in the ileum four inches above the ileo-cæcal valve. At the seat of impaction circumscribed gangrene and perforation had taken place.

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* Guy's Hospital Reports, 1884.

† Transactions New York Pathological Society, vol. ii., pp. 2, 3.

‡ Pathological Society's Transactions, London, 1854.

§ A case of large biliary concretion in the ileum. Medico-Chirurg. Trans., vol. lv., p. 1.

Fagge,† in his excellent paper "On Intestinal Obstruction," gives an account of a case which he examined, where in a woman 69 years of age who had died with symptoms of intestinal obstruction, a gall-stone measuring 4½ inches in its largest circumference and 2½ inches in its smallest, was found impacted in the jejunum 30 inches below the pyloric orifice of the stomach. The stone had passed from the gall-bladder into the duodenum through a perforation, firm adhesions having prevented its escape into the peritoneal cavity. In two other cases to which the same author refers the patients suffered from intestinal obstruction, and recovery followed after the evacuation of gall-stones of immense size. In cases terminating by spontaneous recovery he believes that perforation takes place into the colon. That the danger is not always passed when a large biliary calculus enters the colon directly through a perforation of the gall-bladder is well illustrated by a case reported by Bourdon,‡ where the calculus became lodged in the sigmoid flexure, where it produced an inflammation which proved fatal. In a number of cases recovery took place by discharge of the calculus per viam naturalis even after the symptoms had pointed to complete obstruction. The largest stone which has been successfully passed was 3½ inches in circumference. Pye-Smith§ narrates a case which would tend to show that in cases of intestinal obstruction due to the presence of a biliary calculus a spontaneous cure is possible even after the symptoms have continued for a number of days. The patient was a female 78 years of age who had never suffered from jaundice, and gave no history of biliary colic. She had always been very constipated ; obstruction finally ensued ; and after some temporary relief became complete. By external palpation no tumor could be felt. On rectal examination, however, the finger could just reach a smooth, hard, moveable tumor, and it seemed probable that there was malignant disease of the colon. After thirteen days complete obstruction, however, the large gall-stone exhibited was passed, and the patient recovered quickly, and has subsequently remained free from the trouble.

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* Impaction of a large Gall-stone in the Ileum. The Lancet, April 27, 1872.

† On Intestinal Obstruction. Guy's Hospital Reports, vol. xiv.

‡ Calcul biliare d'un volume considerable, tombé dans le tube digestif à travers les parois perforeé de la vesicule et du colon transverse. Gaz. des Hôpitaux, No. 72, 1859.

§ British Medical Journal, March 19, 1887.

Treatment.

Foreign bodies when impacted in the intestine set up inflammation, and this may go on to gangrene and perforation, and so it can be explained how cathartics under such circumstances are more likely to do harm than good. If impaction has taken place near the ileo-cæcal valve or in the colon, large injections and massage may be tried, provided symptoms of severe inflammation or gangrene at the site of impaction are absent. In the great majority of cases, however, the local lesions at the site of impaction are of such a nature at the time surgical aid is summoned that nothing short of a laparotomy will promise any hope of success. It will be well for the surgeon not to place too much importance upon the presence of tympanitic distension of the abdomen in these cases as an indication for the necessity of an abdominal section, as this sign may be entirely absent if the impaction is located high up in the intestinal tract, and if the impaction is in the lower part of the ileum or colon an operation should not be postponed until such distension has taken place. After the abdomen has been opened in the median line, and the seat of obstruction determined, the course to be pursued will depend upon the pathological conditions at the seat of impaction. As the mucous membrane in contact with the foreign body is always first to suffer in consequence of the impaction, puncture and incision should be avoided at this point. As the cases must be few where such a stone, even soon after impaction has taken place, can be pushed along the intestinal canal and through the ileo-cæcal valve into the colon, submural crushing of the stone should be practised where attempts at distant displacement have failed, and where the condition of the intestinal wall is such that no fear need be entertained that gangrene or perforation will take place. The stone should never be attacked at the seat of impaction, but should be pushed in an upward or downward direction, and then removed if possible by breaking it up by manual pressure, or, if this fail, the method suggested by Tait,* of passing in a needle obliquely through the intestinal wall and attacking the calculus in this manner may be tried. A stout steel needle, such as is used for electrolysis is best adapted for this

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* The Lancet, December 10, 1887.

purpose. The needle should always be introduced obliquely through the intestinal wall an inch or two below the impaction in order to secure healthy tissue for the seat of puncture. After the stone has been crushed and the debris within the gut has been pushed into a healthy segment of bowel below, the puncture in the serous coat should be closed by drawing the peritoneum over it with a fine superficial suture for the purpose of guarding against leakage. When efforts at submural crushing or fracturing of the enterolith have failed and it is deemed necessary to excise it, it is also advisable to push the foreign body within the gut in an upward or downward direction sufficiently far to bring it to a perfectly healthy portion of the intestine, as the healing process of the visceral wound made for its extraction would proceed more satisfactorily here, than where the tunics of the intestine had undergone pathological changes in consequence of the impaction. If the stone cannot be displaced and the incision must be made through an inflamed intestinal wall, a graft of omentum should be placed around the intestine after suturing the visceral wound so as to cover the wound, and its ends fastened together by two sutures passed through the mesenteric attachment. Such a procedure will place the visceral wound in the very best condition for healing and will furnish an additional safeguard against subsequent perforation. If the intestine at the site of impaction shows evidences of gangrene, or, if perforation has already taken place no efforts should be made to extract the stone, as under such circumstances the surgeon is compelled to resect that portion of intestine in which the stone is imprisoned. As patients presenting such conditions are always more or less collapsed it becomes of the greatest importance to finish the operation as rapidly as possible, consequently after the resection has been made in the usual manner the continuity of the intestinal canal should be restored by an operative procedure which can be executed without unnecessary loss of time. As the bowel above the seat of obstruction is always found greatly dilated, circular enterorrhaphy for this reason alone would be a difficult if not an impracticable task, hence both ends of the intestine should be invaginated to the extent of an inch and the invagination maintained by three or four superficial stitches of the continued suture, and the continuity of the intestinal canal restored by making an incision an inch in length in each closed end of the bowel on the convex surface about two inches from the sutured extremity and lateral apposition of the wounds secured by decalcified perforated bone plates. This method should always be preferred to circular enterorrhaphy in uniting the bowel after resection under such circumstances as the extensive and secure coaptation of serous surfaces greatly enhances the chances of early union between the coaptated bowels, and at the same time establishes a communicating opening equally serviceable as after circular suturing.

b. Intestinal Concretions.—We have already seen that a small gall-stone when retained for a sufficient length of time in the intestinal canal may become the nucleus for an intestinal concretion, which by the addition of concentric layers gradually increases in size until it fills the lumen of the bowel and after its impaction gives rise to intestinal obstruction. Enteroliths causing obstruction have been described in which a variety of foreign bodies have been found as nuclei.

Cloquet* divides the concretions found in the alimentary canal into two classes. The first includes enteroliths in man, and bezoars in animals, both being the result of calcareous deposits secreted by the parietes of the intestines. The second class comprises abnormal masses, such as solids (animal or vegetable hairs which have escaped the process of digestion, and agglomerate to form ægagropilæ) pulvurent substances and foreign bodies such as kernels of fruit, biliary calculi, and hardened fæces. He described an enterolith which formed around a pin as a nucleus by deposits of phosphate of lime and which had become arrested in the cæcum where it caused the death of the patient. In another case he found that the nucleus was composed of an ivory pessary which had perforated the bowel on one side and the bladder on the other, the perforation in the bowel was covered by a concretion of phosphate of lime, while the part in the bladder was encrusted with uric acid.

Aberle† reported a case where chronic intestinal obstruction was caused by the presence of 32 enteroliths, each of which was composed of a concretion in concentric layers around a cherry stone as a nucleus. The concretions had collected in the colon and were successfully removed by rectal injections and cathartics. A chemical examination of the concretion showed that it was composed of phosphate of lime and a considerable quantity of fat, animal glue, and traces of cholesterine.

Schoor‡ described an enterolith which for five years had given rise to pain, first in the ileo-cæcal region and later in the left inguinal region, and was finally discharged spontaneously. It measured 4½ inches in length and 2.9 inches in width and weighed 44.9 grammes. On making a section of it, it was found that the central portion or nucleus was composed of a triangular piece of bone around which in concentric layers the concretion was arranged. A chemical examination of the concretion showed that it was largely composed of phosphate of ammonia and magnesia, the remaining part of it consisting in vegetable fibres, coloring material of bile, cholesterine, and chloride of sodium.

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* Amer. Jour. Med. Sciences, January, 1856, p. 216.

† Ein Fall von Steinbildung im Darmkanale. Würt. Med. Corresp. blatt., No. 23, 1868.

‡ Canstatt's Jahresbericht, 1853, B. II., p. 64.

Virchow* made a careful chemical and microscopical examination of an enterolith which had caused symptoms of obstruction in a woman, but was finally expelled after another severe attack of colica stercoralis. The stone measured 5 ctm. in length and 8.5 ctm. in its greatest circumference. On making a section through its center it was seen to be composed of a plum-stone surrounded by a shell 2 ctm. in thickness, made up of concentric layers of crystalline bodies held together by a brownish mass. Chemical analysis showed that the shell was composed largely of phosphate of ammonia and magnesia.

In Friedländer's case† the obstruction was due to the impaction of an enterolith in the ileum 30 ctm. above the ileo-cæcal valve which was composed of shellac. The patient was a cabinet maker, and it is said that the apprentices of this trade not infrequently consume the alcoholic solution of shellac used for varnishing; in the stomach the alcohol is absorbed, and the shellac is deposited. In this case the stomach contained a large number of the same kind of concretions.

At the meeting of the Congress of German Surgeons in Berlin, in April, 1880, Langenbuch‡ showed some large concretions, some of which he had removed by enterotomy in a patient who had suffered from repeated attacks of intestinal obstruction. As the symptoms became more urgent and failed to yield to simpler measures, abdominal section was performed in the median line, and the operator without much difficulty found a swelling in the jejunum, laid open the intestine, and removed the mass of concretions which completely filled the lumen of the bowel. Vomiting continued and the patient died a few hours after the operation. The necropsy revealed a second still larger mass in the pyloric region of the stomach. Virchow examined the concretions and found that they consisted almost exclusively of organic substances, and especially of the derivative of the biliary acids known as dyslysin.

The surgical treatment of intestinal concretions is the same as in cases of impacted gall-stone.

c. *Parasites as a cause of Intestinal Obstruction.*—A few cases of intestinal obstruction have been recorded where the obstruction was caused by a mass of ascarides which interfered with the passage of intestinal contents in the same manner as an enterolith. Halma-Grund* refers to a patient ten years of age that came under his care suffering with the characteristic symptoms of acute intestinal obstruction, followed by hæmorrhage from the bowels, collapse and death. The necropsy revealed as the cause of obstruction a mass of ascarides, eighteen in number, which completely filled the lumen of the ileum. At the site of impaction an ulcer was found showing an eroded vessel which had been the source of hæmorrhage.

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* Virchow's Archiv., B. XX., Heft 3 u. 4.

† Schellack-steine als Ursache von Ileus. Berl. Klin. Wochenschrift, 1882, No. 1.

‡ Verh. der deutschen Gesellschaft f. Chirurgie, 1880.

Saurel's† patient was 23 years of age, who suffered from symptoms which resembled closely an attack of intestinal obstruction. A swelling could be felt to the left of the umbilicus. Two ascarides were thrown up during a severe attack of vomiting. Anthelmintics were administered and injections given without any effect, and the patient died in collapse. The necropsy revealed the cause of obstruction to have been a mass of ascarides which were firmly impacted in the lower part of the ileum.

Poekels‡ was called to attend a patient who had suffered for some time from an intra-abdominal swelling the size of a hen's egg which could be distinctly felt below and to the left of the umbilicus. A purge of male fern and jalap expelled 103 ascarides, after which the tumor disappeared and the patient's health was completely restored.

Stepp§ has recently recorded an instance in a boy, aged 4, who died with symptoms of acute intestinal obstruction an hour and a half after medical aid was summoned. The post-mortem showed that the intestine was completely obstructed by a twisted mass of some forty or fifty round worms, lodged just above the ileo-cæcal valve. The ileum contained some thirty-five more higher up, and there were a few in the stomach and œsophagus. The mother of the child had given the patient some worm medicine a few days before the acute attack and Stepp thinks that the worms, weakened by the medicine, were dislodged in numbers by the violent peristalsis set up by an injudicious diet afterwards, and so rolled down in a tangled mass too large to pass the ileo-cæcal valve.

When the surgeon is called upon to treat a case of intestinal obstruction in a child, such a cause should be borne in mind, as in a case of this kind a timely anthelmintic remedy followed by a brisk cathartic may prove efficient in removing the cause of obstruction. If such treatment should prove unavailing, no time should be lost in resorting to operative treatment by abdominal section, which is to be conducted in the same manner as in operations for intestinal concretions.

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* Enteritis Verminosa mit Darmblutung u. Einklemmungserscheinungen. Schmidt's Jahrbücher, B. 99, p. 92.

† Darmverstopfung durch Würmer. Schmidt's Jahrbücher, B. 99, p. 92.

‡ Briefliche Nachrichten über Rundwürmer. Schmidt's Jahrbücher, B. 99, p. 92.

§ Centralblatt f. die med. Wissensch. 1888, No. 27.

d. Fæcal Obstruction.—Fæcal obstruction is almost without exception met with only in the large intestines and here in preference in the cæcal region or in the sigmoid flexure. Cases have been reported where a congenital abnormal dilatation of some part of the colon predisposed to this affection. The acquired form of dilation which attends all cases is the result of prolonged over-distension resulting in paresis of the distended segment of the bowel.

Boys de Loury * has collected a number of cases of retention of fæces in the cœcum and colon which finally gave rise to inflammation at the seat of impaction and intestinal obstruction. Among them was one observed by Nélaton where the fæcal tumor occupying the cæcum and ascending colon by pressure against the under surface of the liver and gall-bladder caused icterus. The icterus and symptoms of obstruction disappeared promptly after the removal of the fæcal accumulation by cathartics. Retention of fæces after a time produces more or less acute enteritis, attended by tympanites, pain, and dyspnœa. The patients usually have been constipated for a long time, sometimes alternated by diarrhœa. The retained fæces become inspissated and hard and form mural concretions, the middle often remaining tunneled for the passage of fluid fæces. The masses are modelled and when thrown off, often describe in accurate outline the contour of the bowel. Distension of the bowel often takes place to an enormous extent. Cruveilhier found on making a necropsy on an old man the transverse colon dilated so that it measured 35 ctm. in circumference. The cæcum was even more dilated and was the size of a child's head. In one of my cases of periodical accumulation of fæces in the sigmoid flexure the patient would only return for treatment at a time when symptoms of obstruction set in and every time he presented himself the swelling would occupy almost the entire space in the abdomen below the umbilicus. Mechanical removal of the fæcal accumulation followed by massage and the use of the Faradic current and galvanism had no effect in diminishing the size of the bowel, or in preventing the periodical accumulation of fæces. If the cæcum alone is the seat of impaction it often presents the appearance of a circumscribed tumor which may and has been mistaken for an ovarian tumor, abscess or carcinoma. The retained mass constitutes an irritant which sooner or later causes a catarrhal enteritis, which extends to the remaining tunics and is often the direct cause of perforation or diffuse peritonitis. In some instances the inflammation extends to the connective tissue around the intestine and an abscess forms without an antecedent perforation. The distended bowel gradually becomes paretic and the local and general symptoms are aggravated.

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* Gaz. hebd., 1858, No. 28.

One of the most important diagnostic points is to make pressure over the tumor in chloroform narcosis when the fæcal masses become displaced, leaving a permanent depression at the point of pressure. If the impaction is within reach the removal should be accomplished by the use of a scoop assisted by copious injections. If the bowel at the seat of impaction has lost its contractility the use of cathartics is useless, and if it is in a state of inflammation positively hurtful. In such cases massage and high injections are indicated. Perforation and suppurative inflammation in the connective tissue surrounding the bowel must be met by prompt surgical treatment. In cases where all ordinary measures fail in removing the fæcal accumulation and the symptoms of obstruction continue unabated, it would be not only justifiable, but good surgery to cut down upon the distended bowel and to break up the mass within the gut and push it along to a portion of the intestine where peristaltic action has not been impaired. In cases where the intestinal wall presents pathological conditions which would contra-indicate such a course of treatment, it may become necessary to resort to enterotomy and remove the fæcal mass through the wound and according to circumstances either close the visceral wound by suturing or establish a temporary artificial anus in one of the inguinal regions.

2. *Invagination.*

Treves * asserts that thirty per cent. of all forms of intestinal obstruction, exclusive of hernia and congential malformations, are cases of invagination. The same author recognizes clinically four forms. The ultra acute is very rare, and terminates fatally in twenty-four hours; the acute, lasting from two to seven days, numbered about forty-eight per cent. of all cases of invagination; the subacute, lasting from seven to thirty days, are about thirty four per cent.; and the chronic, lasting over thirty days, occurred about eighteen times out of every one hundred cases. As far as the operative treatment is concerned it is exceedingly important to classify all cases into acute and chronic, as in the former class the symptoms appear with great violence and the pathological changes at the seat of invagination come on so rapidly that death is inevitable unless efficient surgical treatment is resorted to before the tissues at the seat of invagination have undergone changes incapable of repair. In the chronic form the symptoms are never so urgent and the adoption of early radical measures is not as urgently indicated. Of the anatomical forms, the cases collected by Treves thirty per cent. were enteric ; eighteen per cent. were colic ; forty-four ileo-cæcal, and eight were ileo-colic. The enteric forms are most common at the lower part of the jejunum, and are small. The colic forms are mostly to the left of the transverse colon. The latter as a rule belong to the chronic form of invagination.

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* The Lancet, December 13, 1884.

Leichtenstern * calls an invagination ileo-cæcal when the ileo-cæcal valve is pushed forward and forms the apex of the intussusceptum and ileo-colonic when the ileum is pushed through the valve. The invagination always increases at the expense of the intussuscipiens. In examining four hundred and seventy-nine cases of invagination in reference to the anatomical location of the lesion he gives the following figures:

Ileo-cæcal	212
Ileum	142
Colon	86
Ileo-colonic	39
	479

I shall not endeavor to elaborate upon the views entertained by different authors and experimenters concerning the mechanism of the ordinary forms of invagination, but from a surgical aspect it is important to allude to some of the pathological conditions which produce the invagination, and at the same time complicate the treatment. Mr. Bellamy† has described the case of a very rare form of intestinal obstruction due to invagination of a portion of the small intestine in the walls of the rectum successfully treated by abdominal section. The obstruction had been complete for nine days. The patient was a female who had been subject to obstinate constipation, and on three occasions the retention of fæcal matter had given rise to serious symptoms which, however, had always yielded to ordinary means. On admission into the hospital, a hard swelling could be felt in the left iliac fossa, in the region of the inguinal canal and sigmoid flexure. Manual examination of the rectum disclosed an obstruction in the upper part of this portion of the intestine. As the symptoms of ob-

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* Uber Darm-Invagination. Prager Vierteljahrsschrift f. Heilkunde. B. II. u. III., 1873

† British Medical Journal, March 8, 1879.

struction became urgent and failed to yield to ordinary treatment abdominal section was performed after exploration of the left external inguinal ring which had been the seat of an old hernia, by enlarging the incision upwards and obliquely outwards. On introducing the hand into the abdomen it was ascertained that the swelling in the iliac region was composed of a knuckle of small intestines which was obviously invaginated in the anterior aspect of the first part of the rectum, and in addition there was felt what appeared to the touch to be bands of organized lymph, stretching across in the same place, and probably the result of a former circumscribed peritonitis. The operator introduced his right hand into the rectum and pushed the prolapsed mass upwards and towards his left hand, which was in the pelvic cavity, at the same time breaking down the adhesions and gently drawing out the knuckle from its imprisoned position, and freeing it from the peritoneal fold. The symptoms of obstruction subsided promptly and the patient after having passed through a moderate attack of peritonitis made a complete recovery.

In examining the literature of the subject the author had been unable to find any case where abdominal section had been performed for a similar condition, although Lockhart described this form of hernia, but he stated that he had never known an operation necessary. The cause of a chronic invagination is often a tumor attached to the inner surface of the bowel. The tumor by its weight drags the portion of intestine to which it is attached into the segment of bowel below and the descent of the intussusceptum is often very slow. In these cases the tumor is always found attached to the apex of the intussusceptum. Invagination caused by tumors is most frequent in the large intestines, as these are more frequently the seat of tumors than the intestinal canal above the ileo-cæcal valve. Tuffier[*] reports a case of invagination operated on by Marchand which is of special interest on account of the rare condition found which had led to the invagination.

The patient was a woman 43 years of age, who had suffered from a gradually increasing intestinal obstruction. Rectal examination revealed a tumor which had dragged an upper segment of the bowel with it into the rectum. Marchand opened the abdomen in the left inguinal region and found an invagination of the sigmoid flexure into the rectum. Reduction was found impossible. An artificial anus was established after the method of Littré. Death on the fifth day. The necropsy showed diffuse peritonitis which in the small pelvis had assumed a suppurative type. The sigmoid flexure was found invaginated to the depth of 6 ctm., the serous surfaces adherent, which only gave way to considerable traction force. A pedunculated lipoma was attached to the apex of the intussusceptum.

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[*] Invagination de S'illiaque dans le rectum. Laparotomie laterale. Anus de Littré. Lipome de intestin. Le Progreès Mèdicale, 1882, p. 202.

Kulenkampff* reports a case of a woman, aged thirty-nine years, who had suffered from incomplete obstruction of the bowels with bloody discharge from the anus for six months. During the progress of the disease a mass could be felt in the rectum, which was thought to be a polypus. This proved to be a papilloma (probably malignant) that originated in the sigmoid flexure, and had been the cause of the invagination of that part of the colon into the rectum. The entire mass, including the intussusceptum was removed through the rectum. An adherent coil of intestine was accidentally wounded and the wound was at once closed by suturing. The operation was followed by an aggravation of the symptoms of obstruction, on the tenth day laparotomy had to be performed, and an artificial anus was established in the left groin. The patient recovered, but the fæcal fistula remained.

Bryant† related the case of a lady, aged seventy-four, who had been suffering from obstruction due to invagination for fourteen days. He suspected the existence of a growth, and this, after much difficulty, was found, drawn down, and removed, the patient making a rapid and perfect recovery.

Barker,‡ in a case of invagination of the rectum, due to adenoid epithelioma of that part of the gut, succeeded in drawing down and excising the affected part and reduced the invagination. The patient recovered completely. Three similar cases had been treated previously in the same manner, two by Verneuil, and one by Kulenkampff, only one of them recovering.

The case reported by Nicolaysen§ is of special interest as illustrating the course to be pursued when it becomes necessary to resect a portion of the intestine with the tumor. The patient was a woman forty-nine years old who had suffered from troublesome constipation and painful defecation for a year, due to chronic invagination of the sigmoid flexure of the colon into the rectum produced by an epithelioma. Through the rectum a tumor could be felt which by traction could be drawn down to the anus. The diagnosis made was a carcinoma of the colon and invagination of colon into rectum. The patient could produce the invagination at will. The extirpation was made by pulling the tumor downwards beyond the anal orifice. The healthy mucous surfaces 2½ ctm. above the base of the tumor were circumscribed by a row of silk sutures which were carried through the entire thickness of both intestinal walls. The tumor was excised 1 ctm. below the sutures, only one artery had to be tied. Posteriorly and on the left side of the circular wound the divided meso-colon could be seen. The wound was accurately united by a superficial continued suture. As soon as the bowel was replaced it retracted as far as the upper portion of the rectum. The patient had recovered after fifteen days and reported herself well at the end of 2½ months. The intestinal tube removed measured 6.5 ctm. The tumor under the microscope showed the typical structure of cylindrical-celled epithelioma.

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* Centralblatt f. Chirurgie, 1886, No. 47.

† British Medical Journal, April 9, 1887.

‡ The Lancet, May 14, 1887.

§ Tumor carcinomatosus intestini S. romani: Resektion af S. romanum; Heltredelse. Nord. Med. Arkiv., B. XIV., No. 13.

Becker* has collected a number of cases from literature where the cause of the invagination was a diverticulum of the small intestine, and he believes that in some of the reported cases of elimination of portions of the intestine with the appendix vermiformis were of this kind, that in these cases what appeared as the appendix was in reality a diverticulum.

The mechanical disturbances at the seat of invagination sometimes are the cause of an additional obstruction. In one of Dent's cases in a child six months old, who for three days before admission into St. George's Hopital had suffered from evident intussusception the abdominal section revealed a two-fold cause for the obstruction, invagination and internal strangulation. When the abdomen was opened a loop of bowel was found constricted by the sharp edge of a piece of mesentery of the ileum which was invaginated into the cæcum. The band was divided and the invagination easily reduced. Peritonitis had set in before the operation, and the child died in five hours after it. This case should remind us to look for additional causes of obstruction around the site of the invagination in all cases where the abdomen is opened in the treatment of intussusception. Similar care should be exercised under the same circumstances after the reduction has been accomplished to look for an additional invagination, as cases have been reported where two or more invaginations were present at the same time.

Claudot† has given an accurate description of a specimen of double invagination in a patient who had died with symptoms of intestinal obstruction. The first invagination was 80 ctm. below the pylorus, the second two metres further down, the latter consisted of an invagination of the ileum into the colon, the intussusceptum having advanced nearly the entire length of the ascending colon. The upper invagination showed evidence of gangrene, of which no sign could be seen in the lower, and for this reason it is probable that the upper invagination occurred first. Intestinal hæmorrhage was one of the prominent symptoms during life in this case.

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* Zur Aetiologie der Darmeinschiebung. Dissertation. Kiel, 1885.

† De l'occlusion intestinale. Thèse, Paris, 1884.

At a meeting of the Pathological Society of London, Power* demonstrated a specimen obtained from a child five months old of double intussusception, one in the ileo-cæcal region two inches in length, the other in the transverse colon, one inch in length. The latter was an ascending invagination. Both invaginations showed adhesions between the serous surfaces, and consequently must have been antemortem conditions.

In regard to the age of patients suffering from invagination, it can be said that fifty per cent. of all cases occurred in persons under ten years of age. According to Heusner in children invagination is the cause of obstruction in three-fourths of all cases of intestinal obstruction. If all cases of invagination were tabulated it would be seen that one-fourth of the whole number would be children under one year of age. The acute form is most frequent in the young, and the chronic variety between the ages of twenty and forty.

Leichtenstern† has studied the mortality which attends invagination, and in 557 cases in which the termination was known the result was as follows:

Age.	Total mortality.	Mortality of cases without elimination of gangrenous portion.
1 year	88	86
2 years	82	
2–10 "	72	80
11–20 "	63	86
21–40 "	63	82
41–50 "	63	80
51–60 "	71	
More than 60 years	77	

From this table it can be seen that the mortality up to the age of forty increases with the diminution of the age of the patients, being greatest in infants and children in whom the invagination usually pursues an acute course.

Pathology of acute Invagination.

The pathological changes in the acute form of invagination are chiefly of two kinds: 1. Obstruction of the bowel; 2. Strangulation of the intussusceptum. Both of these results may be absent in the chronic form. The obstruction is not only due to the narrowing of the lumen of the bowel by the invagination, but also to the swelling of the invaginated portion caused by the constriction of the blood vessels supplying the intussusceptum at the neck of the intussuscipiens. In cases of chronic invagination where no such vascular engorgement is present the lumen of the intussusceptum remains sufficiently large for a free passage of the intestinal contents, and no symptoms of obstruction are observed. In a number of my experiments on animals where I produced invagination artificially no symptoms of obstruction were observed, and when the animals were killed weeks or months after the invagination had been made, the lumen of the intussusceptum was not larger than an ordinary lead pencil, and yet the bowel on the proximal side was not dilated, but somewhat hypertrophic. The greatest danger after invagination has taken place arises from the constriction of the intussusceptum at the neck of the intussuscipiens. The acuity of the symptoms are always proportionate to the severity of the strangulation at this point. The circular constriction interferes with the return of venous blood from the intussusceptum which is followed by œdema, complete stasis and gangrene of the constricted portion. An acute invagination becomes irreducible to ordinary means within a few hours on account of the appearance of œdema in the intussusceptum. If the strangulation is less intense the passive congestion precedes a plastic inflammation of the serous surfaces held in apposition and adhesions form which again oppose or render a reduction impossible. In cases where gangrene of the invaginated portion follows a few hours or days after the invagination no adhesions form between the serous surfaces. Adhesions at the neck of the intussuscipiens and throughout the extent of the invagination may form soon and they may be absent after six weeks in the chronic variety. Adhesions are met with in about 80 per cent. of chronic cases, and 40 per cent. of acute ones. In acute cases a fatal termination usually takes place from perforation at the neck of the intussuscipiens followed by septic peritonitis. Numerous cases have been reported where a spontaneous cure was effected by sloughing and elimination of the intussusceptum. This favorable termination is only possible if the continuity of the intestine is restored at the neck of the intussuscipiens by firm unyielding adhesions before the proximal end of the intussusceptum has become gangrenous, or if the line of demarcation is below the neck. Gangrene usually commences at the apex of the intussusceptum and travels in the direction of the neck. That sloughing and elimination of the intussusceptum are not always followed by recovery becomes evident from a study of 149 cases collected by Leichtenstern where this occurred. Out of this number 61 died and 88 recovered, a mortality of 41 per cent. Separation of the gangrenous intussusceptum usually takes place in acute cases from the eleventh to the twenty-first day, and in children somewhat earlier than in adults. The length of the slough corresponds with the length of the invaginated portion, and cases are on record where recovery followed after the elimination of five or six feet of intestine. According to Treves spontaneous elimination takes place in about 40 per cent. of all cases. The frequency with which it takes place in the different anatomical forms varies, being 20 per cent. in the ileo-cæcal form, 28 per cent. in the colic and 61 per cent. in the enteric form, so that it is most rare in the most common variety. The frequency of elimination of the gangrenous part increases with the age of the patient, being least common in infants on account of the rapidly fatal course of the disease in them, and most frequent in patients advanced in life.

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*Transactions, vol. xx., p. 240.

† Ueber Darminvagination, iii. Theil, Prager Vierteljahrsschrift f. Heilkunde, B. XXX., p. 17.

Birch-Hirschfeld* gives an accurate post-mortem description of a child two years of age which had recovered from a double invagination by sloughing an elimination of the intussusceptum, and died four months later of measles. At the necropsy it was found that the lower portion of the ileum, the cæcum and appendix vermiformis were absent. A circular cicatrix in the lumen of the gut showed where separation had taken place ; upon the serous surface at the same point a circular depression indicated the site where separation had occurred. The second invagination had evidently been in the colon at the junction of the ascending with the transverse portion, as a similar cicatrix was also found in this locality. The cures after spontaneous elimination of the intussusceptum are often more apparent than real as such an ideal restoration of the intestinal canal as described by Birch-Hirschfeld is but rarely effected.

Kuettner† has followed up the history of several of these cases and has found that not an inconsiderable number of them die later of perforation and peritonitis. Stricture of the intestine has also been observed as a sequela in some of these cases.

Gerry‡ reports such a case. The invagination was acute and after three weeks a portion of the small intestine, 17½ inches in length, passed per anum followed later by a number of smaller fragments. Soon after the apparent recovery had taken place, symptoms of obstruction again set in, due to the formation of a stricture at the point where spontaneous resection had taken place from the effects of which the patient died seven months after the invagination. At the necropsy a circular stricture was found in the upper part of the small intestine, with loss of several feet of the intestine by sloughing, a fistulous communication between the small intestine and the descending colon and chronic peritonitis.

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* Fälle von Geheilten Invaginationen des Darmes. Archiv der Heilkunde, 1869, Heft 1, p. 108.

† Drei Fälle von Intussusception und deren præsumptive Heilung. Virchow's Archiv., B. LIII., p. 274.

‡ A case of Intussusception. Boston Medical Journal, 1877, No. 25.

Pathology of Chronic Invagination.

In cases of chronic invagination the symptoms are identical with those of intestinal stenosis from other causes. The constriction at the neck of the intussuscipiens is not sufficient in degree to arrest the circulation in the invaginated portion, consequently gangrene does not take place. The seat of the invagination and the bowel on the proximal side become the seat of hyperplastic changes from the chronic congestion which attends the lesion and from the increased peristalsis which is maintained by the chronic obstruction.

Pohl[*] has described an interesting specimen of chronic invagination taken from a man 62 years of age who suffered from two attacks of intestinal obstruction eleven years apart. The second attack proved fatal after an illness of eleven days. The post-mortem appearances indicated that invagination which was found had existed for eleven years, and that the second attack was due to an aggravation of the mechanical difficulties at the seat of invagination, and which had given rise to ulcerative inflammation of the mucous membrane lining the intussusceptum, perforation and suppurative peritonitis. The intussusception was located in the lower portion of the ileum. The intussuscipiens was 30 ctm. in length, its muscular coat hypertrophic, mucous membrane thickened and very vascular, and some of its folds adherent to the enclosed intestine; on the posterior wall near the mesenteric attachment two perforations were found. The intussusceptum was 24 ctm. in length and its mucous membrane extensively ulcerated, old and firm adhesions at the neck of the intussuscipiens. The mesentery of the ileum throughout, but especially at the seat of invagination, much thickened. Ileum above obstruction dilated and its walls thickened.

Leichtenstern[†] reports a case of chronic invagination which presents a number of interesting points. The attack was brought on by indiscreet diet and was attended by well marked symptoms, tenesmus, liquid stools mixed with mucus and blood. The patient lived for eleven weeks. After the first few days the stools were normal in size and consistence. Recurring colicky pains, often very severe, constituted the most troublesome and important symptom. A swelling in the region of the transverse colon could always be felt, but became firmer and more circumscribed during the attacks of colic or after a prolonged examination by palpation. The necropsy revealed an ileocæcal invagination, the lowest portion of which consisted of the point of entrance of the ileum into the colon, the inner cylinder of the cæcum and ascending colon, and the outer cylinder or sheath of the transverse colon. All of the parts involved in the invagination were the seat of hypertrophic changes.

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[*] Ueber den Befund einer durch viole Jahre getragene Darm-Intussusception. Prager Med. Wochenschrift, 1884, No. 21.

[†] Darm-Invagination von monatlicher Dauer. Deutsches Archiv. f. Klin. Medicin, B. XII., p. 381.

Treatment.

Early recognition of the existence of invagination is of the greatest importance for successful treatment, as the prospects for successful reduction by ordinary surgical means diminish with the development of secondary pathological conditions at the seat of invagination. Many of the artificial invaginations which I made in animals were reduced spontaneously within a few hours, and in order to study the effects of invagination I had finally to resort to suturing at the neck of the intussuscipiens in order to permanently retain the invaginated portion. Reduction was resisted after a time either by the swollen, œdematous intussusceptum or by the adhesions at the neck of the intussuscipiens, or between the serous surfaces throughout the invaginated portion of the bowel. From these observations I have come to the conclusion that reduction by gentle but efficient distension of the bowel below the invagination would succeed in the majority of cases if this procedure were practised before either of the two principal conditions which cause irreducibility have had time to make their appearance. As soon as the existence of an invagination is suspected the large intestines should be emptied of their contents by the administration of a large enema, the patient being kept in Hegar's position. After this has been done the patient should be placed thoroughly under the influence of an anæsthetic so as to facilitate the next step in the treatment by

Rectal Insufflation of Hydrogen Gas.

As gas can be readily forced beyond the ileo-cæcal valve this method of treatment is applicable in the treatment of invagination in any portion of the intestinal canal, and as distension of the intestine below the seat of obstruction may prove successful in correcting the mechanical difficulties due to other causes it should be resorted to both as a diagnostic and therapeutic measure in the beginning of all cases of intestinal obstruction if a correct diagnosis cannot be made without it. The modus operandi of this surgical resource I witnessed in an animal on the third day after the invagination had been made by opening the abdomen and exposing to sight the seat of invagination before the insufflation was made. In this instance two inches of the ileum were invaginated into the colon and fixed by two fine silk sutures at the neck of the intussuscipiens. On the third day the abdominal cavity was reopened by an incision along the outer border of the right rectus muscle, and the invaginated bowel drawn forward into the wound. The bowel at point of operation was very vascular, and the neck of the intussuscipiens covered with plastic exudation. The sutures were removed and the rectum and colon distended with gas for the purpose of effecting reduction. As soon as the colon had become thoroughly distended the adhesions which had formed gave way with an audible noise, and complete reduction followed in such a manner that the part last invaginated was first released. As the force necessary to rupture the adhesions and to reduce the bowel produced no injury of any kind to the intestine below or at the seat of invagination, this experiment would tend to prove that insufflation can be practised successfully in cases of invagination of several days duration. The rectal insufflation of hydrogen gas in the reduction of an invagination should always be made under the influence of an anæsthetic administered to the extent of complete muscular relaxation. The pressure upon the rubber balloon should be uninterrupted and should never exceed two pounds to the square inch. Disinvagination is effected by inflation by two distinct forces. In the first place, the steady elastic pressure of the gas distends the bowel between the sheath and the returning cylinder which makes traction upon the neck of the intussuscipiens, while the column of gas by its pressure against the apex of the intussusceptum acts as a direct reduction force. In order to accomplish the desired mechanical effect the inflation must be made slowly and continuously, as when this is done there is less danger of rupturing the bowel than when rapid inflation is made under the same pressure, but with interruptions, and the object of the inflation is more surely realized. The return of the gas is prevented most effectually by an assistant pressing the margins of the anus against the rectal tube. A small gutta percha female syringe makes the best rectal tube. A sudden diminution of pressure indicates either that disinvagination has been effected or that a rupture of the intestine has occurred. It is exceedingly important that the surgeon should satisfy himself of the existence of a rupture if this accident has occurred. The best way to recognize the accident is to continue the inflation under a pressure of not more than a quarter to half a pound to the square inch. If the invagination has been reduced the intestine above it will become gradually distended by the gas, and the distension of the abdomen takes place first over the middle of the abdomen and above the pubes, ascending gradually as the inflation is continued in an upward direction. If the intestine has been ruptured the gas escapes into the peritoneal cavity and the existence of the accident is proved by the appearance of a uniform free tympanites with disappearance of liver dullness. In a recent case there is no danger of rupturing the bowel under a pressure of two pounds to the square inch, and in cases where the tissue of the intestine yields under this pressure a laparotomy is the only proper remedy and the occurrence of the accident renders the indication for the performance of the operation imperative without adding to its danger.

Colotomy.

Two indications for colotomy might arise in the treatment of colic invagination : 1. In acute cases when the general symptoms are so grave as to contra-indicate a laparotomy. 2. In irreducible chronic cases, when the lower portion of the colon is invaginated into the upper part of the rectum where it is impossible to make a resection or anastomosis by lateral apposition. According to the location of the invagination the operation is made either in the right or the left iliac region, in the former instance the opening being made in the cæcum, and in the latter in the descending colon.

Dubois* reports a case of intussusception where the invaginated portion could be felt in the region of the sigmoid flexure through the abdominal wall. Colotomy was performed above the seat of obstruction and the patient not only recovered, but four months later the permeability of the intestinal canal was restored spontaneously but the artificial opening had not closed.

Enterotomy.

In irreducible iliac and ileo-cæcal invagination an enterotomy should only be made when the patient is in such a collapsed condition that more radical measures are inadmissible. As in the majority of cases the invagination is below the ileo-cæcal valve the artificial opening should be made in the right iliac region. Should the invagination be located higher up in the intestinal canal, and an empty collapsed coil of intestine present itself in the opening it should be pushed aside and search made for a distended loop. An enterotomy is justifiable even when the patient is in an almost pulseless condition, as this operation is attended by little, if any shock, as it can be done in a few minutes, and, if necessary, without an anæsthetic. Emptying the bowel above the seat of obstruction will bring relief by removing the abdominal distension and by favorably influencing the invaginated part by diminishing the hydrostatic pressure above the obstruction, which in itself is a potent cause in maintaining vascular engorgement.

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* Enterotomie pratiquée in extremis. Journ. de Méd. de Bruxelles, December, 1878.

Langenbeck * saved the life of a patient suffering from invagination of the colon by an enterotomy. The invagination had advanced so far that the apex of the intussusceptum could be felt in the rectum. He performed Nélaton's operation and the patient recovered. Nine months after the operation both the invagination and the artificial anus remained.

Laparotomy.

Remembering that the general mortality of invagination is 70 per cent. and in children less than eleven years of age spontaneous cure by elimination of intussusceptum does not exceed 12 per cent., it becomes plain that in cases where reduction is not accomplished by rectal inflation a laparotomy is indicated in all instances where the general condition of the patient is such as to justify such a procedure. It is true that the experience of the past in the operative treatment of invagination is not such as to inspire confidence, but it must not be forgotten that almost without exception the abdomen was only opened as a last resort after the patient had been completely prostrated by the disease or after the invagination had given rise to irreparable local conditions. Instead of discouraging operative interference the statistics collected so far furnish the best possible argument in favor of early operations where simpler measures have failed.

Ashurst † brought together, with more or less detail, the histories of thirteen cases in which laparotomy has been undertaken for the relief of intussusception. Of this number five recovered, and eight died. As the result of a study of his cases he has come to the conclusion that the operation is not admissible in patients less than one year of age, as all operations to that date done in children less than a year of age proved fatal. He also advises against an operation when the symptoms present, and particularly the existence of intestinal hemorrhage, render it probable that the tightness of the intussusception will lead to sloughing of the invaginated portion, as he claims that under these circumstances an operation would almost surely fail, while there is a fair hope that separation of the invaginated mass may lead to spontaneous recovery. Experience has shown that a cure by spontaneous elimination of the intussusception seldom if ever takes place in very young children and infants, consequently the hopelessness of the situation in such cases where legitimate efforts at reduction have failed can be advanced as the most logical reason in favor of operative treatment as the patient and surgeon have nothing to lose and everything to gain.

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* Vorstellung eines Falles von geheilter Enterotomie. Verh. der deutschen Gesellschaft f. Chirurgie, 1878.

† Laparotomy for Intussusception. Amer. Journ. Med. Sciences, July, 1874, p. 48.

Knaggs * after reporting an unsuccessful case of abdominal section for invagination that occurred in his own practice gives the results of thirty-seven operations including his own. Of this number eight recovered, and twenty-nine died. In many of these cases peritonitis had set in before the operation was performed, and this condition and not the operation was answerable for the subsequent fatal issue.

Sands † has tabulated the records of twenty-one cases of laparotomy for intussusception, eight of which have occurred since the publication of Ashurst's paper. Of twenty cases in which the result of the operation is given, seven recovered, and thirteen proved fatal, thus showing a mortality of 65 per cent. After a study of these cases he came to the conclusion that the prognosis after operation is also influenced by the age of the patient; thus of twelve cases of two years old or under, three recovered, and nine died. Of seven cases sixteen years old or over, four recovered, and three died, showing that the mortality is greater in infants than adults. Sands remarks very properly that the mortality depends more on the condition of the intestine than the age of the patient. In taking all cases together he has found that the mortality of the operation is 14 per cent. in the easy, and 91 per cent. in the difficult cases.

The largest number of operations for invagination has been collected by Braun.‡ He tabulated fifty-one operations which were performed since 1870, that is, operations done under antiseptic precautions. Of this number, eleven patients were cured, and forty died. In twenty-seven of these cases disinvagination was effected, and in twenty-four it was not; of the former eighteen were children, and nine adults. Four children recovered, while fourteen died. Seven adults lived and two died. Resection of the invaginated portion was practised twelve times with only one recovery. An artificial anus was established in nine cases, followed by death in every instance.

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* The Lancet, June 4, and 11, 1887. † New York Medical Journal, June, 1887.

‡ Verh. der deutschen Gesellschaft f. Chirurgie, 1885.

Treves[†] gives the general mortality in one hundred and thirty-three recorded cases as 72 per cent.; where reduction was easy it was 30 per cent., and when difficult 91 per cent. No one can look over these tables without noticing that the mortality was greatly influenced by the local conditions, as when the reduction was easy it was greatly reduced. This fact alone should convince us that laparotomy should be resorted to without delay as soon as a faithful attempt at reduction by rectal insufflation has demonstrated that reduction cannot be accomplished in any other way. The operation should be done as a first, and not as a last resort. As in cases of strangulated hernia the obstacles to reduction become more persistent as time advances, and the danger is augmented in proportion to the time which elapses until reduction is attempted. In reference to the time when the operation should be done, I can only caution against delay and make the positive statement that it should be done as soon as it has been shown that reduction cannot be effected by rectal insufflation. The age of the patient should not enter into consideration in deciding upon the propriety of an operation. Sands operated successfully upon an infant only six months of age, where the ordinary treatment by injection and inflation had been only partially effective in accomplishing disinvagination. The cæcum and appendix vermiformis and a small portion of ileum remained firmly fixed in the sheath and it required considerable traction force to release them.

Godlee[†] performed abdominal section successfully for invagination in a child nine months old, four days after the commencement of acute symptoms. In this case the invagination had progressed so far that the apex of the intussusceptum protruded at the anus.

Mr. Hutchinson[‡] narrates the particulars of a successful abdominal section for intussusception in a child two years of age. The invagination had commenced in the ileo-cæcal region and during the course of one month had advanced to such an extent that the intussusceptum was extruded several inches at the child's anus. As rectal injections failed in reducing the bowel the abdomen was opened by an incision through the linea alba below the umbilicus and the intussusceptum was then easily found, and as easily reduced. The child made a rapid recovery.

As a rule, to which there should be no exception, the incision should be made in the median line as it furnishes the most ready access to the invagination and enables the operator to apply the various surgical resources with the greatest facility. For special indications a lateral

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[*] The Lancet, December 13, 1884.

[†] The Lancet, December 16, 1882.

[‡] Medical Times and Gazette, Nov. 29, 1883.

incision can be made later. If the swelling has not been previously located by palpation or insufflation, it is usually not difficult to find the seat of obstruction. As soon as the invaginated part has been found it should be brought into, or as near to the wound as possible for careful examination, as the future action of the surgeon will be guided by the local conditions of the invaginated bowel. If on examination no evidences of gangrene are found efforts should be made to effect reduction.

a. Disinvagination.—In recent and especially acute cases, I am satisfied that the difficulties which resist reduction are not to be sought in the presence of adhesions as often as in the swollen œdematous intussusception. The same measures should be resorted to to enable reduction as in the preliminary treatment of a phimosis or paraphimosis. *The œdema and inflammatory swelling should be removed before any efforts at reduction are made. This can be readily accomplished by steady and uninterrupted manual compression of the invaginated portion.* As soon as the swelling has been reduced in this manner, reduction is attempted by making gentle traction upon the bowel above the neck of the intussuscipiens. Should this fail, inflation is practised, and as soon as the bowel between the returning cylinder and the sheath has become expanded, traction is again made upon the upper and lower ends. If this maneuvre fails to effect reduction, Rydygier's device* of making traction above and pushing from below can be tried. Rydygier also directs that reduction should be facilitated by inserting the finger between the intussusceptum and the intussuscipiens for the purpose of breaking up adhesions. Any one who has had much experience with such cases must have observed that the neck of the intussuscipiens grasps the bowel very tightly and that any such efforts as the introduction of a finger would be almost certain to result in a rupture of the bowel. If the treatment as above directed does not effect reduction the presence of adhesions must be suspected. These should be broken up not by the introduction of the finger, but by inserting and passing around the bowel a Kocher's director or a small probe. When the adhesions have been severed the efforts at reduction by traction and inflation are repeated.

Roser has suggested that after reduction has been effected the invaginated portion should be sutured to the abdominal wall for the purpose of preventing re-invagination. Under proper treatment it is not very likely that re-invagination will take place, and such fixation might subsequently result in another form of intestinal obstruction. Re-invagination can positively be prevented by shortening the mesentery at the point of invagination by folding it upon itself in a direction parallel to the bowel and maintaining it in this position by a few catgut sutures.

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* Beilage, Centralblatt f. Chirurgie, 1887, p. 60.

Should repeated attempts at reduction fail, one of two courses of treatment may be pursued: 1. The establishment of an intestinal anastomosis. 2. Resection of the invaginated portion with or without circular enterorrhaphy. Resection of the invaginated portion, especially if the invagination is extensive, is a very grave undertaking, as it requires a long time for its execution, a matter of vital importance in these cases, and it involves the removal of important parts, and on these accounts should never be resorted to unless the invaginated parts show evidences of gangrene.

b. Intestinal Anastomosis.—An intestinal anastomosis between the bowel above and below the invagination by decalcified perforated bone discs can be made in fifteen minutes, and at once restores the continuity of the intestinal canal. As soon as the hydrostatic pressure above the obstruction has been removed by this operation, the danger of gangrene is diminished, and the bowel may again become permeable by a subsequent spontaneous reduction or by elimination of the intussusceptum. If the invagination remains permanently it does no particular harm as the obstructed portion has been excluded by the anastomosis and subsequently undergoes atrophic changes. In cases where the intussusceptum has advanced beyond the sigmoid flexure, it would become necessary after ligation to remove a part of it through the lower incision in order to render the bowel permeable below this point. I have in my possession a number of beautiful specimens of intestinal anastomosis obtained from animals in which I had made an artificial invagination and subsequently treated them by making an intestinal anastomosis, and I am firmly convinced that the same treatment will prove useful in practice.

Korcynski* reports an exceedingly interesting case where intestinal anastomosis was established spontaneously in a case of invagination followed by a cure. The patient was 41 years of age, and the symptoms of obstruction had lasted for six weeks but were completely relieved by the new opening. The existence of such an opening could be readily verified by digital exploration of the rectum. After the symptoms of obstruction had subsided, the exclusion of a part of the intestinal tract could be ascertained by insufflation of the rectum, which at once produced a tympanitic distension of the middle of the abdomen without distension of the colon. A similar but small communication has been found on post-mortem examination as in the case reported by Gerry and referred to in another part of this paper.

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* Zwei Fälle von Darminvagination langer Dauer. Virchow u. Hirsch's Jahresbericht, B. 11, p. 193, 1881.

c. *Resection.*—The only indication for resection is furnished by gangrene of the invaginated portion. The extent of the gangrene is immaterial in reference to the advisability of making a resection, as a small gangrenous spot necessarily would lead to perforation and death from septic peritonitis, unless this radical measure is adopted. The resection must always include the entire intussusceptum, but not necessarily the entire sheath. The first evidences of gangrene upon the external surface of the bowel appear about the neck of the intussuscipiens, and when the invagination is extensive and the lower portion of the sheath presents a healthy appearance it is only necessary to resect the neck of the intussuscipiens and the intussusceptum which after division and isolation about the neck can be drawn out and removed. The bowel above and below the proposed points of section should be tied with a rubber band to prevent fæcal extravasation during the operation. The mesenteric attachments must be tied in small sections with fine silk ligatures, as tying in larger sections or with catgut is liable to be followed by hæmorrhage. After the resection has been made it becomes a serious question how to proceed farther. Shall the continuity of the intestinal canal be restored at once by suturing or shall an artificial anus be established? When the resection involves the ileum above and the colon below, it is exceedingly difficult to restore the continuity of the intestinal canal by circular enterorraphy on account of the difference in the lumina of the bowel to be united. As ileo-cæcal invagination is the most common form, it is evident that as a rule some other plan must be followed. Under these circumstances one of two methods of procedure can be chosen. The colon at the point of division is inverted to the extent of an inch or more, and closed by making a few stitches of the continued suture which should embrace only the serous and muscular coats, and the iliac end is implanted into a slit, corresponding in size to the circumference of the bowel, made in the colon on the side opposite to the meso-colon at a point just below the closed end. Fixation is most effectually secured by rubber ring and two inversion sutures as described in my paper read at the last meeting of the International Medical Congress, to which should be added as a matter of precaution a superficial continued suture. If lateral implantation cannot be readily done an equally efficient method consists in closing both ends and establishing the continuity of the intestinal canal by lateral apposition with decalcified perforated bone plates in the same manner as has been described under the head of intestinal anastomosis. Restoration of the continuity of the intestinal canal after resection of an invaginated bowel by lateral implantation or lateral apposition requires much less time than a circular enterorrhaphy, while both operations secure better conditions for definitive healing than circular enterorrhaphy, and on these accounts should under these and similar circumstances be preferred to the latter procedure.

In cases of colic invagination requiring an extensive resection approximation of the two ends is not possible on account of the distance they are separated from each other and the comparatively slight immobility of this part of the intestine. In such a case lateral implantation is impracticable for the same reasons. The choice lies between the establishment of an artificial anus and lateral apposition; the former should never be made, as in case of recovery of the patient the fæcal fistula would remain as a permanent condition without any prospects of an ultimate cure. The continuity of the intestinal canal can be restored at once in these cases by making an ileo-colostomy, or a colo-colostomy by lateral apposition with perforated decalcified bone plates, according to the location or extent of the resection.

Wassiljew * reports a very interesting case of resection for invagination which ultimately terminated in recovery. The patient was a man, aged twenty-five years, who was seized with abdominal pain and vomiting. As the symptoms of obstruction did not yield to ordinary treatment, laparotomy was performed on the second day. On opening the abdominal cavity a swelling was readily detected in the right hypogastric region. This swelling was drawn forwards, and found to be an extensive invagination of the ileum into the colon. As reduction could not be accomplished an elastic ligature was tied around the gut in two places and the ileum and mesentery were divided. Then the invaginated portion was readily withdrawn and about seventeen inches were resected. The abdominal cavity was washed out with a solution of sublimate and the cut ends of the gut were fixed by sutures to the abdominal wound. Much gas and fæcal matter escaped, when the ligatures were united. During the sixth week an operation was performed for the cure of the artificial anus. About six inches more of the intestine were resected and the cut ends united by Czerny's suture. On the third day the bowels moved, but on the fifth day the fæcal discharges again escaped through the wound. The different attempts to close the fistulous opening failed. Digital exploration showed that a spur was beginning to form. To this spur a pressure forceps was applied; it fell off on the third day; ultimately the fistula closed.

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* Invaginatio ileo-cæcalis. Laparotomia, Resectio intestini. Heilung. Centralblatt f. Chirurgie, 1888, No. 12.

3. *Volvulus.*

Volvulus or twisting of a loop of intestine around its axis constitutes a well-defined form of intestinal obstruction. This pathological condition can only occur where the mesentery of the bowel is of considerable length and is therefore most frequently met with in the lower portion of the ileum and at the sigmoid flexure of the colon. This condition as compared with some other forms of intestinal obstruction is quite rare, as in one thousand five hundred and forty-one cases of obstruction from different causes collected by Leichtenstern * and analyzed with special reference to the anatomical cause of the obstruction, after deducting one hundred and seventy-eight due to carcinoma, thirty-three cases only were due to twisting of the bowel, this including twists of both the sigmoid flexure and the ileum. Upon another page the same author gives the result of his examination of seventy-six cases of volvulus which he has collected, and of this number the lesion was found in forty-five cases in the sigmoid flexure, in twenty-three cases in the ileum, in eight cases the jejunum and ileum combined. A simple twist of a long loop of intestine one-half to once around its axis does not necessarily lead to intestinal obstruction. I made a number of experiments on animals by rotating a loop of intestine from one-half to twice around its axis and keeping it fixed in this position by suturing at the base of the loop, and yet no obstruction was produced. These experiments are interesting, inasmuch as they show that the primary constriction produced in making and maintaining the volvulus which was sufficient to cause venous engorgment in the twisted loop must have been only of short duration, the disappearance of the constriction being undoubtedly due to the gradual yielding of the sutured parts, while the faulty axis of the twisted loop was maintained by the sutures the circulation improved and remained in a sufficiently vigorous condition to adequately nourish the most distant portions of the volvulus. In most cases where I made a volvulus artificially the animals did not suffer from intestinal obstruction, and yet the examination of the specimens showed that the twist had remained. The shortness of the mesentery had undoubtedly a great deal to do with the restoration of the circulation in the twisted loop, as this portion of the bowel immediately after fixation always presented a cyanosed appearance. While it was found difficult to force fluid through the specimen of a volvulus, during life, propulsion of the intestinal contents by peristaltic action was carried on in a satisfactory manner, as the bowel above the volvulus was not dilated, and contained no abnormal amount of fluid, and the animals manifested no symptoms indicative of intestinal obstruction. In cases where death has been produced by volvulus the post-mortem appearances will show that the obstruction was caused not so much from mechanical causes as from the secondary pathological conditions in the twisted loop. The abnormal length of the mesentery found in these cases precludes the possibility of partial or complete spontaneous reposition, and the consequence is that the parts involved in the volvulus become the seat of serious vascular disturbances which lead to œdema and paresis. These secondary conditions are followed by distension of the intestine and accumulation of intestinal contents which cannot fail in aggravating the mechanical difficulties which initiated the obstruction. A number of these points are well illustrated by a case of volvulus reported by Wilson.* A boy, nineteen years of age, without any premonitory symptoms was suddenly seized with symptoms of acute intestinal obstruction. Colicky pains and persistent vomiting were the most conspicuous symptoms. Tenderness over the umbilicus and slight fullness between pubic arch and umbilicus. Whole abdomen tympanitic. Pulse rapid and small. Skin pale and cold. The patient died thirty-two hours after the commencement of the attack. The necropsy showed moderate distension of the intestines, which were also found congested. Four or five loops of the small intestines occupying the hypogastrium were of a deep purplish black color, and gangrenous. They were also considerably more distended than the surrounding gut, and taken together they compared exactly with the outline of the circumscribed tympanitic distension observed during life in this region of the abdomen. On careful examination these blackened coils of intestine were found to constitute a portion of the ileum, five feet in length, tightly twisted upon itself in its mesenteric axis. The lower point of crossing was five inches above the ileo-cæcal valve. At the point of crossing of the upper and lower end of the volvulus the intestines were flattened and, with the corresponding mesentery tightly twisted upon itself, forming a firm, hard cord-like pedicle about an inch and a half in length, and a little more than one-third of an inch in diameter. The twist was from left to right, and amounted to a complete turn upon the vertebro-enteric axis of the mesentery. The gangrene and rapidly fatal termination in this case were due to the compression of veins at the base of the volvulus and not to the obstruction. In reference to the causation of volvulus a number of theories have been advanced. All authors are agreed upon one point, in that the mesentery must be of abnormal length.

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* Ziemssen's Cyclopædia of the Practice of Medicine. Amer. Transl., vol. iii.

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* Amer. Journal Med. Sciences, July, 1878, p. 78.

Grawitz* asserts that the immediate cause of a volvulus is to be found in an accumulation of intestinal contents above a constricted portion of bowel. The distended portion of intestine above the seat of constriction undergoes elongation and that this elongated portion then rotates around its axis. Henning † studied the ætiology of volvulus experimentally. He ligated the intestine in animals firmly and then injected water above the seat of obstruction. In the small intestines the distended and elongated coils above the ligature always showed a tendency to rotate upon their vertebro-mesenteric axis, and thus a volvulus was produced. In the large intestines on account of the shortness of the mesenteric attachment, the same experiment caused rupture of the bowel before a volvulus could be produced. He collected a number of cases of volvulus scattered through literature where in the post-mortem description of the twisted bowel it is distinctly stated that the lumen of the intestine was narrowed by some form of acquired or congenital stenosis. While it cannot be denied that chronic obstruction may be a direct or indirect cause of volvulus by producing not only elongation of the intestine, but also of the mesentery above the seat of obstruction many cases have been reported where no such condition was found, and where, therefore, the lesion was due to other causes.

Nieberding ‡ has recently called attention to another cause of volvulus. He has reported a case which occurred in Bumm's practice where after an ovariotomy a volvulus of the small intestine occurred which proved fatal after a few days. During the operation, the omentum, which was adherent to the cyst, was separated and a portion was excised. The necropsy showed that the raw surface of the omental stump had formed an adhesion to a loop of the small intestine and above the fixed point a volvulus was found. He reported another and somewhat similar case which came under his own observation. A large cysto-sarcoma of the left ovary was removed in a girl twenty-nine years of age. Before closing the wound it was noticed that the omentum was so short that the intestines could not be covered by it in the region of the incision. At the end of the second day symptoms of acute obstruction set in, the temperature remaining normal. As the symptoms increased in gravity and the ordinary treatment proved fruitless, the wound was opened and a loop of intestine was found adherent to the left margin of the peritoneal wound, and after this was

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* Virchow u. Hirsch's Jahresbericht, 1876, B. I, p. 284.

† Beiträge zur Kenntniss der Pathogenese des Volvulus. Dissertation. Berlin, 1883.

‡ Beitrag zur Darmocclusion nach Ovariotomie. Centralblatt f. Gynekologie, 1888, No. 12.

separated a volvulus was detected. The bowel was untwisted and its contents forced into the segment farther down beyond the seat of obstruction and the detached loop pushed beyond the reach of the abdominal wound and the abdomen closed. The day after the operation the intestinal canal appeared to be permeable as gas escaped per rectum, but evidences of peritonitis set in and the patient died with symptoms of collapse. He believes that the peritonitis was produced by the obstruction.

G. Braun* reports a case of volvulus in a woman occurring at the end of pregnancy and believes that the pressure of the gravid uterus upon the sigmoid flexure produced the obstinate constipation which preceded the attack and gave rise to elongation of the mesentery and bowel above the seat of compression to a sufficient extent to cause volvulus. At the time she was admitted into the hospital the abdomen was enormously distended, nausea but no vomiting. On the next day labor pains set in and she was delivered of a dead child. On the same day vomiting commenced and a tendency to collapse was observed. The day after delivery she complained of intense pain in the abdomen, difficulty in breathing, and great prostration, and in a few days she died, the symptoms pointing to an intestinal obstruction remaining constant. At the necropsy the sigmoid flexure and its mesentery were found greatly elongated and rotated twice around its axis. That volvulus is not a frequent complication of pregnancy becomes apparent from the statement of Braun, that this was the first case in sixty thousand deliveries which had come under his own observation.

Kuettner† had unusual opportunities to study this form of intestinal obstruction, as four cases came under his own treatment in the short space of two and a half years. As predisposing causes he mentions advanced age, emaciation, as the latter is attended by an absence of fat in the omentum and mesentery which renders the peritoneal cavity more spacious. Abnormal length of mesentery and intestinal tract is also enumerated as an important element in the causation of volvulus. Among the exciting causes he mentions as the most important unequal distribution of intestinal contents and exaggerated peristalsis. He never observed peritonitis in any of his cases even if life was prolonged for five or six days. He believes that in these cases the rapid fatal termination is due to pressure upon the sympathetic nerves which causes paralysis and destroys life in the same manner as peritonitis.

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* Enterostenosen in ihrer Beziehung zur Gravidität und Geburt. Wiener Med. Wochenschrift, 1885, No. 24.

† Ueber innere Incarcerationen. Virchow's Archiv., B. XLIII, p. 478.

He asserts that the complicated forms of knotting of the intestines which are still described in the text-books as rare but distinct forms of obstruction are only varieties of volvulus.

Treatment.—Treves in his paper on "The Operative Treatment of Intestinal Obstruction* claims that this form of obstruction is only aggravated by forcible rectal injections, as such a procedure will tend to tighten rather than to relax the twist. Of the operative treatment he says that simple laparotomy is an unpromising procedure, but that in the future he will make the incision in the median line, puncture the gut, and attempt its reduction ; if this fail, or the result appear unsatisfactory, he will evacuate the involved gut through an opening in the summit of the flexure, unfold the volvulus, and establish an artificial anus, using the opening just mentioned for that purpose. In some cases of volvulus the rotation around the vertebro-mesenteric axis is often less than one complete circle and before the involved bowel has become considerably changed by the twist a reduction might be effected by dilating and elongating the bowel below the seat of obstruction, thus bringing the same causes to bear which have produced the displacement, but in an opposite direction. Careful inflation with hydrogen gas soon after the obstruction has occurred will be a harmless procedure, and in favorable cases might lead to the desired result. That this method of reduction should not be tried after the twisted loop has become softened and greatly distended by intestinal contents requires no explanation. Of all forms of intestinal obstruction volvulus leads most rapidly to a fatal termination. This fact alone is a sufficient warning to lose but little time by temporizing measures. If life is to be saved prompt operative treatment must be adopted. After the symptoms have become sufficiently well marked, if insufflation proves unavailing, laparotomy should be resorted to at once without reference to the time which has elapsed. If the abdomen is opened before the bowel has undergone serious pathological changes reduction will not be difficult, and as the intestine is otherwise in a healthy condition the prospects of a favorable termination are good. In such a favorable case it would not only be prudent, but imperative to resort to means to prevent a recurrence of the volvulus. As an elongated mesentery plays the most important rôle in its production the best prophylactic means against a recurrence would be to shorten the mesentery. Resection of the mesentery is out of question, as such a procedure might result in gangrene of a corresponding portion of the gut. Shortening of the mesentery, however, can be effected by folding and suturing the mesentery in the same manner as has been described in treating of the operative treatment of invagination. Such an expedient would shorten the mesenteric attachment without interfering with the intestinal circulation. If the twisted portion of the intestine presents evidences of gangrene, resection becomes necessary, and after it has been done the continuity of the intestinal canal should be restored by circular enterorrhaphy or by lateral approximation with decalcified perforated bone plates. If reduction cannot be accomplished without evacuating the distended bowel an incision should be made on its convex surface at the summit of the loop, and its contents removed by pouring it out, taking, of course, all the necessary precautions not to soil the peritoneal cavity. After this has been done the visceral wound should be sutured and another attempt made at reduction. If this does not succeed and the symptoms are such that the necessary time required for resection would prove an element of danger, the volvulus should be left and the obstruction rendered harmless by establishing a communication between the bowel above and below the volvulus by lateral apposition with decalcified perforated bone plates.

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* The British Medical Journal, August 29, 1885.

4. *Obstruction by Flexion and Adhesion.*

Every pathologist who has carefully examined the intestinal canal of persons who have acute peritonitis must have noticed the presence of numerous flexions caused by visceral and parietal adhesions, and yet such patients seldom exhibited well marked symptoms of intestinal obstruction during life. I have observed the same conditions in animals during my experimental work on the intestinal canal and seldom found that simple flexion gave rise to intestinal obstruction. I have made numerous flexions when performing operations for establishing intestinal anastomosis, and in most instances satisfied myself by examination of the specimens that fluids passed them without great difficulty. If the bowel at the point of flexion remains free, certain portions of its wall will yield to pressure from within of the fluid intestinal contents, and gradually the lumen of the bowel will become restored. If, on the other hand, the entire circumference of the bowel at the point of flexion has become fixed and immovable by inflammatory adhesions or other pathological products, a compensating dilatation becomes impossible and flexion becomes a direct and serious cause of obstruction. In recent cases of flexion of course the circumference of the lumen of the bowel at the point of flexion is equal in size to that above or below the obstruction. The obstruction in such cases is not caused by stenosis, but by compression of the distal limb of the flexion by the intestinal contents in the proximal portion, thus causing a valvular closure not at, but just beyond the seat of flexion. This is more likely to take place if the apex of the flexed portion of the bowel is adherent to some fixed point, as in this case compensatory dilation of the intestinal wall at a point corresponding to the apex of the flexion cannot take place. When a flexion has existed for a long time without having given rise to symptoms of obstruction, it finally may cause occlusion by a cicatricial stenosis at the seat of flexion due to a circumscribed plastic inflammation and cicatricial contraction of the inflammatory product. Such a case came under the observation of Obalinski.* A boy, eighteen years old, had suffered from typhoid fever eight months before the attack of intestinal obstruction set in. Some time before the acute symptoms appeared he suffered from pain in the abdomen which gradually increased in intensity until the clinical picture of obstruction was well marked. On the eighth day after the attack the abdomen was opened by a median incision. Distended and collapsed intestinal coils came within easy reach. The obstruction consisted of a rectangular flexion of the small intestine caused by a pseudo-ligament the size of a lead pencil. After division of this band and straightening the bowel, it was seen that it was considerably contracted at the point of flexion by a circular cicatrix, but as it was permeable nothing further was done. The boy was discharged cured four weeks after the operation. That the pressure of intestinal contents in the proximal bar is exerted mainly upon the spur which forms in acute flexions between the two bars, is well shown by a specimen described by Birkett† where an intestinal anastomosis was established spontaneously by ulceration between the approximated adherent tubes at the point of compression, so that the intestinal contents passed directly from one intestine to the other through this "fistula bimucosa" instead of traversing the loop. The patient was a man, aged fifty-eight, who six months before his death had presented a strangulated hernia that had been reduced by taxis. When the flexion is very acute, the spur formed by the apex of the approximated walls of both bars acts like a valve in closing the lumen of the distal bar under the influence of the hydrostatic pressure from the accumulation of intestinal contents above the seat of flexion. Nicaise‡ has reported a typical case of this kind. A man, aged twenty-five years, was operated upon for strangulated hernia five years before the attack of intestinal obstruction. Since the herniotomy he had suffered frequently from attacks of vomiting and constipation with abdominal pain. The last attack was so severe that enterotomy was performed. He died the next day. The necropsy revealed an acute flexion which had become permanent by old adhesions. The flexion was so acute that the mucous membrane at its apex constituted a kind of valve across the lumen of the bowel. After liberation of a flexed bowel the seat of an intestinal obstruction it becomes a step in the operation to resort to such prophylactic measures as may appear necessary to prevent a return of the malposition and to cover as far as possible the peritoneal defects which have been made during the separation of the loop. Winslow* reports a case in point. In this case a loop of the small intestines was found firmly adherent in the pelvis over an area of six inches and sharply flexed. After it was carefully detached it was found denuded of peritoneum over a small space. The continuity of the peritoneal surface was restored by applying a number of sutures transversely to the long axis of the bowel. It is distinctly stated that this portion of the bowel was deeply congested, hence the seat of the texural changes consequent upon the obstruction. In most cases of flexion which have been described in connection with intestinal obstruction the flexed bowel was found either in the pelvis near the internal inguinal rings, or in the ileo-cæcal region, localities where localized peritonitis is most frequently met with. If, after the reduction of a strangulated hernia the replaced loop of intestine is or becomes the seat of a plastic peritonitis it forms an attachment to the abdominal parietes or viscera with which it comes in contact. In case the adhesion thus formed remains firm and is not drawn out in the form of a band, or a flexion may form by the free portion of the bowel changing its relative position, and the two bars of the flexion thus formed, when in close contact and the seat of the same plastic inflammation become adherent and the flexion becomes permanent. If the continuity of the bowel cannot be restored by separation of the adhesions in the operative treatment of obstruction caused by flexion and the tissues at the seat of obstruction present no evidences of gangrene an anastomosis between the two bars of the flexion should be made in preference to resection and circular suturing. Circumscribed spots of gangrene can be excised and the wound sutured transversely to the long axis of the bowel as this will cause no stenosis and will tend to correct the faulty position of the bowel. As in cases of constriction by bands, if it is found difficult to separate the adhesions no attempt should be made to liberate the gut until a rubber ligature has been applied to each bar of the flexion to prevent fæcal extravasation should the bowel be ruptured during the separation.

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* Weitere Beiträge zur Laparotomie bei inneren Darmocclusionen. Wiener Med. Presse, 1886, Nos. 4–12.

† Pathological Soc. Transactions, vol. x. 1859.

‡ Bulletin et Mem. de la Soc. de Chirurgie, Paris, 1880, p. 583.

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* Amer. Journal Med. Sciences, vol. xli., p. 411.

Adhesions.—Quite recently a number of abdominal surgeons have published their experience in reference to the occurrence of intestinal obstruction after laparotomy. A number of cases of intestinal obstruction which occurred soon after ovariotomy were found to have been caused by extensive parietal adhesions of the intestines, hence the question has been discussed how such adhesions are to be prevented.

P. Mueller* has advised that in difficult ovariotomies adhesions of the intestines amongst themselves and with the abdominal walls should be prevented by avoiding external compression by bandages and by filling the abdominal cavity with a physiological solution of common salt (0.7 per cent.) For the purpose of limiting peritoneal absorption he suggests that the solution should be introduced from time to time and finally should be withdrawn through the drainage tube.

Olshausen† has found in all the cases of intestinal obstruction after ovariotomy that occurred in his practice that the obstruction was caused by adhesion of an intestinal loop to the surface of the stump. Mueller's prophylactic treatment he considers rational, especially in cases where the operation is attended by considerable hæmorrhage. Schatz holds that visceral and parietal adhesions of the intestines after ovariotomy are a much more frequent condition than is generally believed. He is of the opinion that serious consequences do not necessarily follow such condition. Gusscrow asserts that adhesions are frequently found on making a second laparotomy in the same patient without having produced any outward symptoms.

Kaltenbach now uses a 1–6000 solution of sublimate in place of carbolic acid solution, and since he has made this change he has not observed a case of intestinal obstruction in fifty-four consecutive larparotomies, while of twenty-four cases where carbolic acid was used he lost two cases from this cause. Kruckenberg attributes to the use of sublimate an influence in causing plastic adhesions and asserts that since he has abandoned this agent he has had no cases of internal obstruction after ovariotomy. Sänger's experiments appear to prove that for the formation of a firm and permanent adhesion only one wounded surface is necessary. Schwarz believes that parietal adhesions along the internal surface of the abdominal wound are of frequent occurrence because intestinal loops are caught in the furrow of peritoneum along the line of suturing, where an additional irritation is met with on the part of the sutures.

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* Zur Nachbehandlung schwerer Laparotomien. Archiv. f. Gynaekologie, B. XXVIII, Heft 3.

† Verh. der Deutschen Gesellschaft für Gynækologie, 1886.

Martin* as early as 1865 reported two cases which illustrate one of the dangers which follow puerperal pelveo-peritonitis. In one case the peritonitis followed a manual separation of the placenta. The patient made a rapid recovery, but six weeks latter symptoms of acute intestinal obstruction developed from which the patient died on the fourth day. On post-mortem the cause of obstruction was found to be a firm pseudo-membranous band which connected the anterior surface of the cæcum with a coil of the small intestine. In the second case a metro-peritonitis followed a normal delivery which, however, yielded to proper treatment on the fifth day. During the seventh week after delivery symptoms of acute intestinal obstruction set in and the disease proved fatal after a few days. A similar condition as in the first case was found at the post-mortem.

Hirsch† presents at length the results of his observations and researches on intestinal obstruction after ovariotomy to one of three causes: 1. Adhesions of an intestinal loop to abdominal incision and occlusion from the traction of the cicatrix. 2. Aseptic plastic peritonitis which by causing extensive adhesions results in immobilization of a considerable portion of the intestinal canal which leads to coprostasis and complete obstruction. 3. Impaction of an intestinal loop between a pedicle, treated by the extra peritoneal method, and the abdominal wall. Sir Spencer Wells reported eleven deaths from this cause in 1000 cases of ovariotomy. Usually the obstruction occurs soon after the operation, but several years may elapse before the accident takes place. The symptoms are the same as in the obstruction from other causes.

The prognosis in cases of obstruction from intestinal adhesions is extremely unfavorable. Of the fourteen cases collected by the writer, only one recovered after secondary laparotomy. In view of the great mortality which attends this the most serious complication after laparotomy it is exceedingly important to resort to proper prophylactic measures in all cases of intra-abdominal operations. In the first place, when the operation is done in an aseptic peritoneal cavity all irritating antiseptic solutions should be kept from coming in contact with the peritoneum, as their local irritant action might produce a plastic peritonitis. The peritoneum should not be unnecessarily bruised or sponged, as a slight traumatic irritation may be productive of a circumscribed adhesive inflammation. Finally it should be the aim of the surgeon to restore, if possible, the continuity of the peritoneal surface should any defects be found during or caused by the operation before the abdomen is closed. Adhesion of the intestines to the abdominal incision can be prevented by spreading the omentum carefully over the intestines the whole length of the incision. Limited defects can be readily closed by suturing. The cut surface of the pedicle after ovariotomy should be covered by stitching the peritoneum over it. The stump after supra-vaginal amputation is treated in a similar manner. Parietal and visceral defects not amenable to suturing can be covered with an omental graft which is stitched to the margins of the defect with catgut sutures. In cases of intestinal obstruction due to extensive adhesions after operations, or attacks of circumscribed peritonitis, it is essential to resort to early operative treatment which consists in separating the adhesions and in restoring peritoneal defects as far as possible for the purpose of guarding against similar attacks in the future. After the intestine has been liberated it is advisable to place the detached portion in some part of the abdominal cavity where a similar condition is less likely to occur.

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*Zwei Fälle von Darmeinklemmung durch Exsudatfäden nach Wochenbetten. Monatsschrift für Geburtskunde, July, 1865.

†Archiv f. Gynækologie, B. XXXII., Heft 2.

5. *Strangulation by Ligamentous Bands or Diverticula.*

Ligamentous bands resulting from old adhesions are usually found in parts of the abdominal cavity most frequently the seat of peritonitis, viz: in the pelvis and the ileo-cæcal region. Their formation can generally be traced to a broad parietal adhesion which by the peristaltic action of the free portion of the intestine has become elongated and often narrowed to a delicate cord. It becomes a cause of obstruction when the migrating or free end forms an attachment to some fixed point which renders then the band tense and unyielding, and in case a loop of intestine becomes ensnared underneath it strangulation takes place in the same manner as in strangulated hernia, the constricting cord by its pressure causing venous engorgement below the constriction and by the increased peristaltic action of the proximal limb of the loop forcing intestinal contents into, but not through, the constricted loop. As in hernia, an intestine may have become adherent and fixed underneath such a band for an indefinite period of time without strangulation taking place, as long as the immediate causes of strangulation are absent. Any causes which disturb the mechanical relations still further in such a case, as a fall, lifting, coughing, the administration of an active cathartic, etc., may bring on an acute attack of intestinal obstruction. The history of cases of intestinal obstruction due to the presence of a ligamentous band frequently refers to an attack of peritonitis through which the patient passed perhaps years before and as frequently alludes to one of the above mentioned proximate causes as preceding the attack of intestinal obstruction. A displaced neck of hernial sac may cause obstruction in the same manner as a ligamentous band. Kurz* treated such a case successfully by laparotomy. The patient, a man thirty-three years of age, had been the subject of a small inguinal hernia for several years without causing much inconvenience, when symptoms of acute intestinal obstruction set in, the inguinal canal was carefully examined and was found empty. The symptoms of obstruction were very grave, including a subnormal temperature and fæcal vomiting at the time the operation was performed. Digital exploration of the ileo-cæcal region through a median abdominal incision led to the discovery of a ring in which the colon had become ensnared. Reduction by moderate traction was found impossible, and it was found necessary to incise the ring at two points when the bowel which was deeply congested was readily withdrawn. The ring was found displaced four inches from the internal ring. The patient made a rapid and satisfactory recovery. In other instances the contents of the hernia, either the omentum or the intestinal loop, when in a condition of plastic inflammation may lead to the formation of a ligamentous band when either of these structures become attached too near the intestinal ring the adhesion which forms lengthening out until it is attached to some other fixed point. Obre† described the post-mortem appearances of such a case. The strangulated loop had wandered to near the xyphoid cartilage; while between it and the inguinal ring a cord seventeen inches long was found. A band of constriction can also be formed by the margins of an opening in the mesentery or omentum in which a loop of intestine can become strangulated. In such cases it becomes necessary after reduction has been effected to close the opening by sutures to prevent a possible relapse of the obstruction from the same cause. An adherent portion of omentum in the course of time may become drawn out into a narrow twisted cord which may become a cause of internal strangulation. In operating for intestinal obstruction caused by constricting bands it is always necessary after relieving the point of constriction first found to search for additional bands as it is not unusual to find more than one. Obalinski‡ made a laparotomy for intestinal obstruction on the third day after the appearance of acute symptoms.

* Deutsche Med. Wochenschrift, March 25, 1885.

† Pathological Society Transactions, 1851, p. 95.

‡ Wiener Med. Presse, No. 4–12, 1886.

On introducing his hand through a median incision he felt in the right iliac region distended and empty coils, and by tracing the latter in an upward direction found as the cause of obstruction two bands each the size of a goose-quill extending from the cæcum to the abdominal wall between which a loop of intestine 30 ctm. in length had become strangulated. Both bands were ligated and divided. Bowels moved on the fourth day and patient was discharged cured in two weeks.

Fowler* has met with two cases where at the autopsy a second band was found close to the divided one.

Another frequent location for bands is in the umbilical region where the remains of the umbilical artery may become a cause of constriction. Polaillon,† in a young man opened the abdomen by lateral incision on right side for intestinal obstruction one week after the appearance of the first symptoms. As the patient was the subject of an inguinal hernia both inguinal canals were examined by digital exploration through this incision, but nothing was found to explain the obstruction. The incision was enlarged and the whole hand introduced, and after careful exploration a falciform fold was found to the left of the median line which extended from the left inguinal ring toward the umbilicus. Between the band and the abdominal wall a sac was found which contained numerous coils of intestine. The whole intestine was carefully examined and finally an empty loop about ten inches in length was found. The cause of strangulation was the peritoneal band, reduction having taken place by the introduction of the hand. The band was not divided for fear of hemorrhage. The patient recovered after a slight attack of peritonitis. Intestinal obstruction by a constricting band furnishes the simplest and most favorable conditions for early operative treatment by abdominal section. Without prompt surgical treatment a fatal termination is almost inevitable as death results either from the mechanical effects of the obstruction or the constriction produces gangrene under the sharp margin of the band followed by perforation and death from septic peritonitis. An operation undertaken before the strangulation has caused great abdominal distension and serious texural changes by pressure or constriction would be almost sure to be rewarded by success. Two cases of intestinal obstruction caused by ligamentous bands recently reported by Bull ‡ illustrate in a most striking manner the importance of early operative interference. Both cases were treated by laparotomy, and the difference in the results obtained was plainly traceable to the length of time which had intervened between the onset of the disease and the operation. In the first case the operation was delayed until the eleventh day and during the separation of the band a gangrenous spot in the bowel gave way, followed by fæcal extravasation. The circumscribed gangrenous patch was excised, making a wound an inch in length, and parallel to the long axis of the bowel, which was closed with twelve Lembert sutures. Death twelve hours after operation. In the second case laparotomy was performed almost under identical circumstances, but the strangulation had existed only six days. In this case the operation was limited to the removal of the cause of obstruction, as the constricted bowel had not undergone irreparable damage and the patient recovered. The operative treatment of the obstruction in this form of intestinal strangulation is usually not attended by any difficulties. The band of constriction, whatever its location or mode of origin, may be is traced to both fixed points of attachment and excised between two ligatures. This not only relieves the strangulation, but prevents a possible recurrence of a similar attack from the same cause. In some instances however, the local conditions may be more complicated. Reali met with a case where it was found impossible to liberate the intestine from a constricting band, and where he divided the intestine at the point of constriction and reunited the ends again by circular suturing, and his patient recovered. If on careful examination the conditions at the seat of constriction are such as to make it probable that the gut is the seat of gangrene from compression underneath the band or that the separation of the band from the intestine is not readily accomplished, no attempts should be made to liberate the intestine until measures have been employed to guard against fæcal extravasation in the event the gut should be ruptured. This precaution consists in emptying the intestine on each side of the constriction to a distance of from two to four inches by displacing its contents in its interior between the thumb and index finger and applying a rubber ligature which is passed through the mesentery with a pair of hæmostatic forceps. The ligatures are not removed until the bowel has been liberated, and if it is injured or presents evidences of gangrene not until its continuity has been restored by suturing or excision, or by establishing an anastomosis after resection.

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* The Lancet, June 30, 1883, p. 1120.

† Gazette Médicale de Paris, April 25, 1885.

‡ Report of Cases of Intestinal Obstruction Treated by Laparotomy. Gaillard's Medical Journal, March, 1888.

From a surgical standpoint in the causation and treatment of intestinal obstruction the appendix vermiformis must be looked upon as a diverticulum. The appendix vermiformis may become a cause of obstruction when it is of abnormal length and supplied by a long mesentery, and when it is transformed into an unyielding band by fixation of its free extremity to some firm point by adhesive inflammation. Greves* reports such a case. A boy, six years of age, who had suffered frequently from attacks of constipation lasting from a few days to a week or fortnight was seized with violent pain in the abdomen and other symptoms of acute internal strangulation. On the fourth day the pain was referred to the iliac region, where a resonant swelling could be located. As the usual means proved of no avail, laparotomy was performed on the fifth day. About twelve inches of the small intestines were found to be tightly strangulated by an abnormal appendix vermiformis, whose free end had become fixed to the iliac fossa, forming a complete ring, through which the small intestine had slipped and became strangulated. Strangulation was relieved by division of ring. Patient had not a single bad symptom after the operation. Excision of the appendix vermiformis, when the cause of obstruction, should always be practiced with a view of preventing a similar attack from the same cause. As in such cases the process has undergone elongation by traction it is sufficient to apply a ligature near its base and then remove it by excision.

Quite a number of cases of intestinal obstruction are on record where the obstruction was caused by a diverticulum, and in a number of these cases the strangulation was successfully treated by laparotomy. To the same class belong bands, the remains of obliterated omphalo-mesenteric vessels.

In 1851 Parise† published his paper on a new cause of strangulation, in which he claimed that he was the first one to show that strangulation may take place from constriction by a diverticulum. The same year Bonvier‡ described a case where a diverticulum of unusual length springing from the ileum three feet above the ileo-cæcal valve encircled a loop of the small intestine so firmly as to give rise to complete obstruction. Where the diverticulum joined the ileum the lumina of both were equal in diameter, but the diverticulum tapered towards its end, ending in a bifid extremity, adherent to intestinal coils. Omentum and abdominal wall furnished the unyielding points. The constriction was not very firm and reduction could have been readily effected had an abdominal section been made.

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* The Lancet, December 6, 1884.

† Mémoire sur le mécanisme de l'etranglement intestinal par un noeud diverticulaire. Bull. del'Acad. de Med., 1851, p. 373.

‡ Note sur un Cas de l'etranglement interne de l'intestin Grêle par un diverticule de l'ileon. Gaz. des Hôpitaux, 1851, No. 87.

Fitz* in an exhaustive article on "Persistent Omphalo-mesenteric Remains," has collected all material facts pertaining to Meckel's diverticulum with especial reference as a cause of internal strangulation. As a result of a careful study of this subject he has come to the following conclusions:

1. Bands and cords as a cause of acute intestinal obstruction are second in importance to intussusception alone.

2. Their seat, structure, and relation are such as frequently admit their origin from obliterated or patent omphalo-mesenteric vessels, either alone or in connection with Meckel's diverticulum, and oppose their origin from peritonitis.

3. Recorded cases of intestinal obstruction from Meckel's diverticulum, in most instances at least, belong in the above series.

4. In the region where these congenital causes are most frequently met with, an occasional cause of intestinal strangulation, viz: the vermiform appendix, is also found.

5. It would seem, therefore, that in the operation of abdominal section for the relief of acute intestinal obstruction, not due to intussusception, and in the absence of local symptoms calling for the preferable exploration of other parts of the abdominal cavity, the lower right quadrant should be selected as the seat of incision. The vicinity of the navel and the lower three feet of the ileum should then receive the earliest attention. If a band is discovered, it is most likely to be a persistent vitelline duct, i. e., Meckel's diverticulum, or an omphalo-mesenteric vessel either patent or obliterated, or both these structures in continuity. The section of the band may thus necessitate opening the intestinal canal or a blood vessel of large size. Each of these alternatives is to be guarded against, and the removal of the entire band is to be sought for, lest subsequent adherence prove a fresh source of strangulation.

According to Schröder† a diverticulum is only supplied with a mesentery when it springs from the lateral aspect of the intestine, or near the mesenteric attachment. Diverticula on the convex surface of the bowel are free and supplied with vessels from the intestinal wall. Meckel found in several specimens a valve at the junction of the diverticulum with the bowel, and in one instance Phoebus found the opening of the diverticulum into the bowel crossed by a bridge of tissue connecting its margins. The so-called false diverticula always form on the concave side of the bowel, and are hernial protrusions, their walls being composed of peritoneum and mucous membrane.

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* Amer. Journal Med. Sciences, July, 1884.

† Ueber Divertikel-Bildung im Darm-Kanale. Dissertation, Erlangen, 1854.

Greenhow* observed a case where a coil of the ileum had slipped through a slit in the mesentery of a diverticulum, which in this case contained omphalo-mesenteric vessels, and had become strangulated in this position. Sometimes a number of congenital diverticula are found in close proximity and at times associated with other congenital defects of the intestine.

Moore† exhibited to the Pathological Society of London the intestines of a man aged forty, showing three diverticula in the first three feet of the small intestine, and a congenital stricture at the commencement of the jejunum. The diverticula were each an inch long and about as much in diameter, and were on the mesenteric side of the intestine. Their walls consisted of all intestinal coats, and were not mere hernial protrusions. As long as the free end of a diverticulum remains unattached, strangulation from this cause cannot take place. Strangulation can only occur when both extremities are fixed, either as a congenital condition, or when later the free end becomes adherent to some fixed point. Harris‡ showed a specimen to the Pathological Society of Manchester of internal strangulation from a man, aged twenty. There was a whip-cord like adhesion about an inch and a half long, stretching from the tip of Meckel's diverticulum to the mesentery of the lower part of the ileum, and through the aperture so formed a loop of the lower part of the bowel had become strangulated. There had also been a twist of Meckel's diverticulum which had ruptured near its base, and death ensued from acute peritonitis consequent upon fæcal extravasation. That the danger of perforation and peritonitis from strangulation by a Meckel's diverticulum is greater than when the obstruction is caused by a ligamentous band, is shown by another case reported by Heiberg.§ The patient was a woman, forty years of age, who died in a few days from an acute attack of intestinal obstruction. At the necropsy he found a diverticulum seven inches in length thirty inches above the ileo-cæcal region, which constricted a loop of the ileum twenty-one inches in length. The free end of the diverticulum had passed between its base and the intestine, and was found here with its terminal end somewhat dilated. The softened wall of the diverticulum was found perforated at one point which had given rise to fæcal extravasation and septic peritonitis. A somewhat similar mechanism of strangulation by a diverticulum was described by Concato.‖ A man otherwise in perfect health was attacked by acute intestinal obstruction and died on the fourth day. A loop of the small intestine was found constricted by a diverticulum located several feet above the ileo-cæcal valve, the free end of which had insinuated itself between the junction of the diverticulum with the intestine and constricted bowel, thus forming a firm knot around the bowel. That in most cases where a diverticulum causes an obstruction the free end has found a firm point of attachment is well shown by the cases tabulated by Cazin.* He collected thirty cases of intestinal obstruction caused by a diverticulum, and of this number in twenty-five the free end was found adherent. A diverticulum may give rise to symptoms of intestinal obstruction without directly interfering with the fæcal circulation. Such a case has been reported by Doran.† A boy, four years old, died on the fourth day after an attack of what resembled acute intestinal obstruction. At the necropsy a diverticulum the size of a pear was found at the junction of the ileum with the jejunum which contained a pea. The foreign body had caused ulcerative inflammation and perforation of the diverticulum and death from perforative peritonitis. The diverticulum was supplied with a mesentery and its walls were composed of all the tunics of the bowel.

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* The Lancet, May 17, 1884.

† The Lancet, Nov. 10, 1883, p. 815.

‡ British Medical Journal, May 28, 1887.

§ Ueber innere Incarcerationen. Virchow's Archiv, B. LIV., p. 30.

‖ Virchow u. Hirsch's Jahresbericht, B. XI., 1871, p. 155.

Southey‡ alludes to another variety of obstruction caused by a diverticulum, viz: contraction of the intestine at a point where the diverticulum is given off. He gives a description of two such specimens. In one the diverticulum formed a band the size of a goose-quill and extended from a point two feet above the ileo-cæcal valve to the abdominal wall two inches below the umbilicus. The ileum just above the diverticulum was so constricted as only to admit the tip of the little finger, and at the point of constriction the coats of the intestine, both muscular and mucous, were ulcerated through, the continuity of the intestine being only preserved by the thickened peritoneum. In the second case the bowel, at a point about eighteen inches above the ileo-cæcal valve, was abruptly constricted to a diameter of about half an inch, and a diverticulum five inches long, having a calibre, large enough to admit the little finger, passed from the intestine and was attached at its extremity to the umbilicus. In this case death was hastened by acute diffuse peritonitis. That not all constricting bands are the remains of the vitelline duct requires no argument in speaking of the operative treatment of obstruction from constriction by bands, but the possibility of mistaking a peritoneal fold enclosing unobliterated umbilical vessels for an ordinary cicatricial band must be remembered and the necessary sections of the band made between ligatures. If Meckel's diverticulum is found to be the cause of obstruction this appendage should always be resected by ligating it at its base with a rubber ligature, and after the excision the end is invaginated and the invagination maintained by a few stitches of the continued suture. Weir recommends in the excision of a constricting diverticulum to apply a ligature and after cutting it off to stitch the peritoneal surface over the divided muscular and mucous coat, but when the diverticulum is nearly of the same diameter as the intestine from which it springs, such a course would not afford ample protection against perforation.

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* Étude anatomique et pathologique sur les diverticules de l'intestin. Thèse. Paris, 1862.

† Case of Acute Intestinal obstruction; perforation of a diverticulum. Transactions of the Pathological Society, vol. xxiv, p. 122.

‡ Transactions of the Clinical Society of London, vol. v., 1872.

Clutton* related a case to the Clinical Society of London, of intestinal obstruction caused by a diverticulum successfully treated by operation. The patient was a boy aged 10 years, who had suffered on several occasions from colicky pains lasting for two or three days and always terminating with a copious evacuation from the bowels. This attack commenced with vomiting and great pain in the abdomen which persisted in spite of opium treatment for four days, when he was brought into the hospital and at once submitted to an operation. On opening the abdomen through the linea alba a collapsed portion of bowel was soon found, and, on bringing it to the surface, a tight ring-like cord could be felt and seen to be the cause of strangulation. The cord was divided between two pairs of forceps and each end tied with a catgut ligature. This step of the operation relieved the bowel from strangulation. On making an investigation as to the nature of the band divided, it was found that one of the ligatures was situated at the extreme end of a diverticulum two inches in length, and the other was placed upon the wall of the same loop of intestine at a distance of about six inches. A portion of the bowel about three inches in length between these two points of attachment was the part strangulated, and was of an extremely dark color with a deep sulcus at each side. The boy made an uninterrupted and rapid recovery.

Clutton explained the condition as follows: "The vitelline duct had become obliterated at the umbilicus, and set free from the abdominal wall, but remaining patent towards the ileum the lower end had become a pouch-like diverticulum from the intestine. This diverticulum terminating in a pointed extremity or cord part also of the vitelline duct which had been obliterated and remained floating about among the intestines till it became attached to the bowel in contact with it. The gut between the two points of attachment had slipped beneath the cord which united them, and being unable to extricate itself had become strangulated.

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* The Lancet, May 17, 1884.

Another interesting case of intestinal strangulation caused by a Meckel's diverticulum and successfully treated by laparotomy is reported by McGill.* The patient was a man, aged 30 years, who had suffered from acute intestinal obstruction for nine days. The abdomen was very much distended at the time of operation. As the seat of obstruction could not be readily found by intra-abdominal palpation, partial extrusion of intestines was allowed to take place, but as soon as three feet of the small intestines had escaped the junction of the distended with the empty intestine came into view. At this point a Meckel's diverticulum much dilated and about six inches in length, was seen, passing downwards, and forwards, to be attached to the fundus of the bladder. A loop of collapsed intestine passed under the diverticulum, the obstruction being caused by the twisting of the bowel at the point where the diverticulum was attached. Slight traction proved efficient in releasing the bowel from the grasp of the diverticulum, and as soon as this was accomplished the empty portion of the bowel became filled with the intestinal contents. Nothing was done to the diverticulum. On the tenth day a small fæcal fistula formed at the lower angle of the wound. This continued two weeks when the discharge ceased and the patient recovered without any further untoward symptoms. The author believes that this is the first recorded case where the free end of the diverticulum had its attachment to the fundus of the bladder. There can be but little doubt that the fæcal fistula in this case was caused by a perforation of the diverticulum, an accident which might have proved fatal if extravasation had taken place into the peritoneal cavity, and which might have been avoided had the diverticulum been removed, which would also have protected the patient with certainty against a possible recurrence in the future of obstruction from the same cause.

6. *Non-malignant Stenosis.*

1. *Congenital.*—Congenital narrowing of the bowel varies in degree from a slight contraction to complete atresia. In my experiments on animals I have shown that when the lumen of the small intestines is diminished one-half in size by partial enterectomy and

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*Remarks on a Case of Acute Intestinal Obstruction due to the Presence of a Meckel's Diverticulum Successfully treated by Laparotomy. British Medical Journal, January 14, 1888.

suturing of the wound in a direction parallel to the long axis of the bowel the function of the bowel is not impaired, and obstruction does not occur, but if the stenosis is carried beyond this point there is great danger of obstruction arising from accumulation of solid intestinal contents on the proximal side of the stenosis. The same holds true of congenital stenosis of the small intestines. Even if the narrowing is considerable no serious symptoms are produced until some foreign bodies collect above the seat of constriction and cause obstruction from coprostasis.

Legg* reports an exceedingly interesting case where a congential stenosis of the ileo-cæcal opening led to chronic obstruction, dilatation of ileum, and finally to perforation into the ascending colon. A female 26 years of age was admitted into the hospital April, 1858. She stated that since she was five years of age she suffered from occasional attacks of colic, perhaps five times during a year, attended by constipation and vomiting. After such an attack eight years ago a number of cherry stones passed with the fæces. Recently the attacks became more frequent, and the last was so severe that she found it necessary to seek admission into the hospital. When admitted she presented many symptoms of obstruction. In the right iliac fossa on percussion a dry crackling sound could be heard and felt. In a few days she again passed a few cherry and plum stones and felt relieved. She was given five gutta percha pills which never passed through. She left the hospital improved and was not seen again until six years later. At this time she again suffered from well-marked symptoms of intestinal obstruction, and during the first few days vomited a number of cherry and plum stones, and a black round mass which on cutting was believed to be one of the gutta percha pills which she had taken six years before. Below the umbilicus the same crackling sound could be heard and felt as before. The symptoms of obstruction gradually became worse and a few weeks after admission she died. At the necropsy the entire colon was found empty and contracted, the ileum very much dilated, so much so that the lower portion measured seven inches in circumference. On opening it fluid fæces and a few fruit stones escaped. Ileo-cæcal orifice contracted so that it would admit only a number nine catheter. Above the ileo-cæcal valve a communicating bimucous fistulous opening the size of a quarter of a dollar had formed between the colon and ileum, and a little above this point another but smaller opening had formed in the same manner by adhesion and perforation. In the small intestines a pint of cherry stones were found, all of them covered with a black crust which on examination proved to contain iron. The author could find in literature only six cases of non-malignant stenosis of the ileo-cæcal opening. In Schrœder van der Kolk's case the opening was even smaller and in the lower portion of the ileum which was enormously dilated a large mass of cherry stones and fragments of bone were found.

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* Congenital Constriction of the Ileo-cæcal Orifice and Dilatation of the Ileum; Retention of Fruit-stones in Jejunum and Ileum. Trans. Pathological Society, vol. xxi., p. 171.

Bourdon* observed another case of congenital stenosis of the ileo-cæcal orifice as narrated by Dor.† The patient was a man, 32 years of age, who had suffered for a month from pain in the abdomen, nausea and vomiting. The bowels were moved with difficulty by cathartics. On examination nothing could be found except a doughy condition of the middle portion of the abdomen where percussion revealed also a certain degree of dullness. He remained two weeks in the hospital without any improvement being noticeable, when he left, but returned two days later. At this time an irregular uneven swelling could be distinctly felt in the right groin. The swelling rapidly increased in size and the patient died in a few days of peritonitis. At the necropsy the small intestines were found very much distended, colon and rectum contracted and empty. Just above the ileo-cæcal valve the ileum was distended to the size of a fœtal head adherent to the posterior abdominal wall, mesentery and intestinal coils. The walls of this pouch were thickened and of a brown color. When opened it was found to contain 120 plum-stones and 92 lead bullets. The ileo-cæcal valve was nearly closed and was permeable only to fluids. The patient had probably swallowed the bullets to overcome obstinate constipation. In all of these cases of congenital stenosis no symptoms were caused by the congenital effect until the foreign bodies which collected above it finally produced death from intestinal obstruction or perforative peritonitis. The clinical history in each case distinctly points to aggravation of the obstruction by the occurrence of coprostasis above the seat of stenosis. The surgical treatment in such cases consists in removing the impacted substances through an incision above the stenosis, and after clearing the bowel of its contents unite it with a similar incision in the bowel below the obstruction by lateral apposition with decalcified perforated bone plates, thus establishing a free anastomosis between the bowel above and below the obstruction, and excluding at the same time permanently from the intestinal circulation the contracted portion of the intestine. Excision and restoration of the continuity of the intestinal canal by circular enterorrhaphy can only be thought of in case perforation has taken place.

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* L'Union 57, 1856. Schmidt's Jahrbücher, B. XCVI, p. 204.

† Gaz. Med. de Paris, 1835, No. 9.

2. *Acquired or Cicatricial.*—Cicatricial stenosis of the intestines is one of the remote consequences of deep ulcerative lesions such as are caused by dysentery, typhlitis stercoralis, tuberculosis, and ileo-typhus. The cicatrix which forms during the reparative stage of the ulceration contracts slowly and gives rise to stenosis and chronic intestinal obstruction. As in cases of congenital stenosis the obstruction often becomes complete and gives rise to acute symptoms when foreign bodies or solid fæces become impacted above the seat of constriction. Not infrequently the causes which have led to cicatricial stenosis are located at the same time or appear successively in different parts of the intestine, producing consequently also multiple strictures.

Sharkey* presented to the Pathological Society of London a specimen of multiple strictures of the ileum taken from a woman 33 years of age, who had suffered frequently from indigestion and vomiting. The immediate cause of death was facial erysipelas. The lower two-thirds of the small intestines exhibited numerous ulcers apparently healed. They were so near together and produced such marked constriction that the appearance of a succession of pouches was simulated. There were no distinct evidences of tuberculosis in the intestine or any of the other organs. In the discussion which followed the demonstration of this specimen Treves spoke of other somewhat similar recorded cases in which typhoid fever and tuberculosis seemed to be excluded. Treves† has described another cause of cicatricial stenosis. He has met with such cases in patients who suffered from a strangulated hernia when the prolonged compression during the strangulation had produced a circumscribed gangrene of the mucous coat. In all of the recorded cases the patients appear to have recovered well from the hernia trouble, and after a varying time to have gradually developed symptoms of cicatricial stenosis of the small intestines.

Another form of cicatricial stenosis of the intestines is caused by the formation of a cicatrix in the peritoneal coat as the result of a circumscribed plastic peritonitis. In this form the mucous and muscular coats are intact, but the bowel is narrowed and puckered by a band of cicatricial tissue. Cicatricial stenosis of the colon is caused most frequently by dysentery, while the same condition in the rectum often appears as a syphilitic lesion. In the treatment of cicatricial stricture of the intestine the question of resection again confronts us. Maydl‡ reports two successful cases of circular resection and suturing for cicatricial stricture of the ileo-cæcal valve. In the first case he relieved the obstruction by an enterotomy and a year later excised the constricted portion of the cæcum and united the ileum with the ascending colon. In the second case the general condition of the patient warranted a radical operation, which consisted in the excision of the cæcum and immediate restoration of the continuity of the intestinal canal by suturing. The condition in these cases for circular enterorrhaphy were unusually favorable as the colon must have been in a contracted state, while the lower portion of the ileum from the prolonged obstruction was much dilated so that the lumina of the resected ends must have been nearly equal in size. Both patients recovered. In the first case where the patient suffered all the inconveniences of an artificial anus for one year, a radical operation by an ileo-colostomy could have been made with no more risk than was incident to the enterotomy, and would have thus avoided the necessity of establishing an artificial anus and of performing a second operation. Where no gangrene or perforation is present, I should strongly recommend the substitution of intestinal anastomosis for resection and circular enterorrhaphy. In cases of multiple stricture where they involve a limited area of the intestine an anastomosis should be made between the intestines at a point above the first and below the last stricture excluding permanently the intervening portion from the fæcal circulation.

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* The Lancet, May 24, 1884.

† Intestinal Obstruction that may follow after Hernia. The Lancet, June 7, 1884.

‡ Ueber einen zweiten Fall von narbiger Striktur der Ileo-cæcal Klappe durch cirkuläre Darmresektion und Naht geheilt. Allgem. Wiener Med. Zeitung, 1881, No. 17.

Eddowes* operated on a case of intestinal obstruction due to a cicatricial stricture where the symptoms were promptly relieved by the formation of an artificial anus, and the patient recovered with a permanent fistula. A woman 46 years old was seized nineteen days before the operation with abdominal pain which had persisted ever since. For twelve days there had been no action of the bowels without enemata ; complete constipation had existed for five days. There was no history of syphilis, tuberculosis or cancer. The abdomen was distended, but soft and free from tenderness ; the walls were very thin, and moving coils of small intestine were plainly seen. The abdomen was opened by an incision four inches long in the median line between umbilicus and pubes. A small quantity of peritoneal fluid mixed with lymph escaped, and the abdominal contents appeared congested. A stricture of the small intestine was soon found, forming a complete obstruction, impermeable even to flatus. An artificial anus was formed at the lower extremity of the wound about two inches from the pubes. The operation was followed by a great sense of relief. The lower portion of the wound suppurated on account of escape of fæces, otherwise the recovery progressed favorably. Seven months after the operation the patient was in perfect health, had gained considerably in weight, and was able to go about her household work as before. The bowels acted very regularly every morning, the motion was gradually formed, and in this case she had very good control, but she was unable to control liquid motions and flatus. On introducing the finger, it was felt to be distinctly grasped by a sphincter. Although the symptoms of obstruction were successfully removed by establishing an artificial anus in the median line, the course of practice is open to serious objections. An artificial anus should never be established in the median incision, as the contact of fæces with the wound necessarily prevents healing by first intention. If such a course is contemplated after the abdomen has been explored through a median incision, a small incision for the enterotomy should be made in one of the inguinal regions and the median incision closed and dressed separately. In following such a course the large incision will heal by primary union and the abdomen can subsequently be opened again to better advantage through the median line for the performance of a radical operation. This, like all similar cases, would have been a proper subject for intestinal anastomosis.

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* The British Medical Journal, July 24, 1886.

In non-malignant stricture of the colon colectomy and circular enterorrahaphy should be done in all cases where approximation of the bowel ends is possible. In multiple strictures of this portion of the intestinal canal resection is inapplicable, and the obstruction can only be rendered harmless and the continuity of the intestinal canal restored by lateral implantation or by establishing an intestinal anastomosis.

Coupland and Morris* have collected a number of cases of stricture of the intestine, and in commenting on the material assert that in three-fourths of all cases the disease affected the lower part of the bowel, being about equally divided between the rectum and the sigmoid flexure. With few exceptions strictures are located below the cæcum. In many of the fatal cases death occurred from perforation either above the stricture or in the cæcum. From Bryant's investigations it appears that one-third of the cases of stricture of the rectum or lower bowel are not malignant, a most important practical point with regard to treatment. He lays down the following general rule for performing lumbar colotomy in cases of stricture of the rectum: "In all cases of cancerous stricture of the rectum or colon, including the annular which are not amenable to lumbar colectomy or anal excision, right or left lumbar colotomy is strongly to be advocated, with the well-grounded hope of relieving suffering, retarding the progress of the disease, and prolonging life even for five or six years. To secure these advantages it is necessary for the operation to be performed before the pernicious effects of obstruction occur."

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* On Strictures of the Intestine; with Remarks upon Statistics as a guide to Diagnosis and Treatment, 1878.

Against lumbar colotomy I have already in another part of the paper entered my protest, and in cases of inoperable carcinoma of the rectum producing evidences of obstruction, I wish to call attention to the method of operating devised by Madelung.* In cases of malignant stricture of the rectum, where it is desirable to exclude the part at and below the seat of obstruction completely and permanently from the fæcal circulation, he opens the abdomen by a lateral incision and divides the colon completely in a transverse direction and as low down as possible. The distal end is closed by invagination and two rows of sutures, and dropped into the peritoneal cavity, while the proximal end is sutured into the wound. This operation secures absolute physiological rest for the diseased portion of the bowel and is less likely to be followed by prolapse, as is the case when the bowel is simply stitched into the wound and opened. Anal extirpation of the rectum, both for cicatricial and carcinomatous stenosis, should always be practised when the obstruction and the local conditions which have caused it can be removed by this method.

7. *Tumors.*

A tumor can give rise to intestinal obstruction in different ways according to its location and anatomico-pathological character. A tumor or swelling outside of the intestinal tube may cause obstruction by compression. A polypoid growth springing from the mucous or submucous tissue interrupts the fæcal circulation either by blocking the lumen of the bowel by its size, or by causing an invagination or flexion. A circular carcinoma produces a stenosis which leads to chronic obstruction, but which is frequently the indirect cause of acute intestinal obstruction when either by additional pathological changes at the seat of the malignant disease or by the accumulation of foreign bodies or solid fæcal masses above the seat of constriction the fæcal circulation is completely arrested.

1. *Non-malignant Tumors.*—Benign polypoid tumors seldom attain a sufficient size to give rise to intestinal obstruction, unless they cause additional mechanical disturbance such as invagination or flexion, conditions which have already been alluded to. If the tumor alone is the cause of obstruction it is removed by laparo-enterotomy. A few cases have recently been reported where the obstruction was caused

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* Modification der Colotomie wegen Carcinoma Recti. Verh. der Deutschen Gesellschaft f. Chirurgie, 1884.

by cysts. In Buchwald's case* the symptoms of obstruction were acute and laparotomy was performed on the third day. The patient was a boy who had previously been in good health. As soon as the peritoneal cavity was opened two cysts attached to the small intestine presented themselves in the wound. As the cysts had produced a sharp flexion 9 ctm. of the bowel including the cysts were resected and the ends united by circular suturing. Twenty-seven hours after the operation the patient died. The necropsy showed that the resected piece was taken from the jejunum one-half metre below the duodenum. One cyst measured 17 and the other 10 ctm. in diameter. The walls of the cyst were white and very thin. The microscopical examination showed that they were composed of the same tunics as the bowel, but the mucous membrane was atrophied and contained no glands. The cysts communicated with each other and the lumen of the bowel. The latter was not diminished in size. The cysts contained a yellowish fluid with a strong odor of aceton. Under the microscope the contents showed cylindrical cells in a state of fatty degeneration, cholesterine crystals, granules of leucin, fat globules, and rod-shaped bacteria, but no intestinal contents. He believes that the cysts had no connection whatever with the vitelline duct.

Kulenkampff † reports the case of a child 3 years old, that had suffered occasionally from colic and constipation, and was attacked suddenly with symptoms indicative of acute intestinal obstruction. Abdomen somewhat tympanitic, but no swelling could be made out by percussion and palpation. Tenderness and slight dulness in the right inguinal region. The boy died on the second day. The autopsy revealed as the cause of death a cyst in the region of the cæcum. The cyst was as large as a man's fist and had thin almost transparent walls. It showed several depressions which gave it the appearance of being composed of three or four parts. It was located in the mesentery of the ileum about 40 ctm. above the ileo-cæcal valve. It did not communicate with the lumen of the bowel and contained a thin chocolate-colored fluid. The mesentery at this point was drawn out like a string and encircled a loop of the ileum. Above this point the bowel was greatly distended. He believed with Roth‡ that the cyst was congenital and had developed from a diverticulum of the ileum. As a rule such cysts are located on the convex side of the bowel, but in this instance it occupied a position opposite.

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* Ueber Darmcysten als Ursache eines kompleten Darmverschlusses. Deutsche Med. Wochenschrift, 1887, No. 40.

† Ein Fall von Entero-kystom. Tod durch Darmverschlingung. Centralblatt f. die gesammte Medicin, 1883. No. 42.

‡ Virchow's Archiv, B. LXXXVI, p. 311.

At first sight the cyst appeared like a greatly distended loop of the intestine. As in both of these cases the cyst had produced intestinal obstruction by secondary mechanical conditions, the operative treatment of the obstruction would include the removol of the primary cause and the correction of the secondary mechanical difficulties. This would include resection of the bowel at the seat of obstruction including the tumor and restoration of the continuity of the intestinal canal by circular suturing.

2. *Malignant Tumors.*—Malignant stenosis of the intestines may be caused either by a sarcoma or carcinoma, of which the former is more frequent above and the latter below the ileo-cæcal valve. A sarcoma in the intestine like in any other organ primarily starts from an embryonal matrix of connective tissue and hence it always has its starting-point in the wall beneath the mucous membrane, while carcinona being an atypical proliferation of epithelial cells either commences in the mucous membrane or its glandular appendages.

a. Sarcoma.—Nicolaysen* reports an exceedingly interesting case of enterotomy for a sarcomatous stenosis of the small intestine. The patient was 28 years of age. A firm nodulated kidney-shaped tumor could be felt in the abdomen below the umbilicus. The tumor was first noticed six months before when it was as large as a hen's egg. In the morning the tumor usually could be felt under the costal arch, while during the day it descended into the hypogastric region where it always caused more pain. As the symptoms of obstruction gradually increased in severity and did not yield to ordinary treatment laparotomy was performed. Median incision 14 ctm. long. It was found somewhat difficult to bring the tumor forward into the wound. The tumor occupied the mesenteric side of the bowel and behind it a number of enlarged lymphatic glands could be felt. Eighteen ctm. of intestine including the tumor and a triangular piece of mesentery were excised and the ends of the intestine united with sutures, embracing only serous and muscular coats, whereupon the proximal end was invaginated to the extent of 2 ctm. and the invagination retained with five Lembert sutures over which the peritoneum was once more stitched with a continued suture of fine catgut. The mesenteric wound was also closed by suturing. The tumor consisted of several nodules the size of a goose egg which had perforated the intestine. Microscopical examination of the tumor and lymphatic glands showed sarcomatous tissue. The patient recovered.

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* Myosarkom des Dünndarmes. Extirpation mit Darmresektion. Centralblatt f. die ges. Medicin, 1886, No. 28.

Bessel-Hagen* described a somewhat similar specimen which he found in a child. A boy seven years old after a trauma suffered from a rapidly growing tumor in the abdomen which resulted in death from marasmus in four months. At the autopsy a large sarcoma of the jejunum was found which had perforated into the gut by necrotic destruction of the interior of the tumor. Microscopic examination proved it to be a small-celled, round-celled sarcoma which had originated in the submucosa of the jejunum. Multiple metastasis in kidneys, on back and in the lymphatic glands. Peritonitic adhesions had caused flexion of the intestine below the tumor and dilatation of the proximal portion from obstruction thus produced. As a sarcoma of the intestine only gives rise to symptoms of obstruction and consequently comes under surgical treatment usually after extensive infiltration of the mesentery and retro-peritoneal tissues has taken place, it is questionable if it is prudent to attempt a radical operation, as in case the patient recovers from the operation an early recurrence is almost inevitable. If a sufficiently early diagnosis were possible resection could be made with a fair prospect of a permanent result, but if the infection has extended to the tissues around the bowel it is more judicious to leave the sarcoma and to exclude the obstruction by an intestinal anastomosis.

b. *Carcinoma.*—In most cases of carcinoma of the intestine the disease commences in the mucous membrane, in which case the parenchyma of the tumor is composed of cells which resemble the columnar epithelium which lines the intestinal canal. Carcinoma is found most frequently in the region of the sigmoid flexure, the cæcum and rectum. A malignant stenosis may have existed for months without symptoms, when of a sudden symptoms of acute intestinal obstruction are developed as in the case related in this paper. In cases of acute intestinal obstruction in elderly people where no cause for it can be found in the abdomen a thorough rectal examination should never be neglected. During my visit in Zurich last year I was present at a very interesting autopsy made by Klebs upon one of Krönlein's patients. A few days before a woman 40 years of age was brought into the hospital presenting well-marked symptoms of intestinal obstruction, which had lasted for two weeks. On examination no cause for the obstruction could be found. The abdomen was very tympanitic rendering palpation difficult and unsatisfactory. Laparotomy was made, but as nothing could be found and the small intestines were enormously distended throughout, inguinal colotomy was performed. The operation was followed by decided relief, the abdomen collapsed and a large quantity of fæces was discharged through the artificial anus; but the patient died of exhaustion the next day. At the post-mortem examination the cause of the obstruction was found 20 ctm. below the artificial anus in the shape of a narrow annular carcinomatous stricture of the colon. In his remarks on the case Krönlein stated that he had observed four similar cases during the time he had been in Zurich. It is not unusual that such a stricture gives rise to no symptoms until suddenly symptoms of complete intestinal occlusion are developed. It would be well in the future, when a similar condition is suspected, to explore if need be the upper portion of the rectum and lower extremity of the colon as far as accessible by Simon's method, as in case the lesion is recognized and accurately located some of these cases might be amenable for a radical operation by incision. Schede* made a resection of the small intestine for carcinoma in a case where the tumor had extended to the abdominal wall. The intestine was excised with the tumor and the ends united by circular suturing. The patient recovered. A few weeks later he returned to the hospital with symptoms of complete intestinal obstruction. The abdomen was again opened and an artificial anus was established. The patient died on the fifth day. The cause of obstruction was a constricting band which was divided during the operation. Schede is of the opinion that in cases of complete obstruction of the bowels by a malignant tumor, excision is contra-indicated as in nineteen cases of intestinal resection for malignant disease, of six cases in which the occlusion was complete all died, while of the remaining twelve where the occlusion was only partial only three died. These statistics should only induce us to endeavor to make a correct diagnosis before urgent symptoms have set in and to resort to operative treatment at a time when the general condition of the patient is such as to warrant a radical operation and the local conditions at the seat of obstruction are favorable to a speedy process of repair. If, after resection of the lower portion of the colon it is found impossible to approximate the two ends of the bowel and the distal end is not sufficiently accessible to make an intestinal anastomosis or lateral implantation, then the course adopted by Gussenbauer† in one of these cases should be chosen. This patient was a man, 46 years of age, who had suffered for years from obstinate constipation. On examination he discovered a tumor the size of a hen's egg in the left hypogastric region, two-fingers breadth below a line drawn from an anterior superior spinous process of the ileum to the other. The tumor could also be felt high up in the rectum by pressing it downwards into the pelvis. The abdomen was opened by an incision over the tumor parallel with the course of the descending colon. The tumor was found to occupy the most prominent portion of the sigmoid flexure, freely movable, and not attached to any of the surrounding organs. A few glands behind the affected portion of the colon were enlarged. Circular resection was made including a corresponding portion of the meso-colon and the enlarged lymphatic glands. On account of too great loss of substance circular enterorrhaphy could not be made, consequently the distal end was closed by invagination and suturing and dropped into the abdominal cavity, while the proximal end was sutured into the external wound. The patient made a good recovery, and at the end of ten months the disease had not returned. Bull* reports two cases of carcinoma of the sigmoid flexure where in each instance he opened the abdomen through the median line and stitched the descending colon into the wound without incising it, reserving this step of the operation until adhesions had taken place. Both patients recovered. In one of these cases he resected six inches of the colon including the artificial anus and the tumor twelve months later, and the patient again recovered from the operation. At the time the report was made the operator had in view a third operation for the closure of the second artificial anus which was made at the close of the second operation. In all cases where the seat of obstruction can be located in the cæcum or colon before the operation the lateral incision should be selected, as it will afford better access to the seat of obstruction than a median incision. If it is found impossible to remove the obstruction, one of two things must be done. If the bowel below the obstruction can be reached an intestinal anastomosis is made, or the ileum is divided just above the ileo-cæcal valve, the distal end closed, and the proximal implanted into the bowel below the seat of obstruction. If resection can be done with a prospect of removing all the diseased tissues it should be invariably practised, as a primary radical operation, and if on account of its extent circular enterorrhaphy cannot be done, the distal end is permanently closed, and the proximal stitched into the wound. If the distal portion can be reached the continuity of the intestinal canal is restored by intestinal anastomis or lateral implantation. If the seat of obstruction cannot be ascertained before the operation and exploration through a median incision locates it in the cæcum, colon, or rectum, it may become necessary to make a lateral incision if a radical operation is decided upon, and when this appears impossible or unjustifiable an intestinal anastomosis or lateral implantation can be made through the median incision, and if on account of the location of the obstruction either of these operations are also inapplicable, an artificial anus should be established in the right or left inguinal region, and the median incision closed and dressed separately.

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* Ulceröses Sarcom des Jejunum bei einen Kinde. Virchow's Achiv, B. XCIX., Heft 1.

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* Verh. der Deutschen Gesellschaft fuer Chirurgie, 1884.

† Zur operativen Behandlung der Carcinome des S. Romanum. Prager Zeitschrift f. Heilkunde, 1881.

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* Gaillard's Medical Journal, March, 1888.

V. DYNAMIC INTESTINAL OBSTRUCTION CAUSED BY SUSPENSION OF PERISTALSIS.

A number of pathological conditions are known to produce symptoms which so closely resemble intestinal obstruction that the abdomen has been repeatedly opened in such cases with the expectation of removing the cause of the obstruction, but no occlusion of any kind could be found. These are the cases that have caused the greatest difficulty in diagnosis, and have often brought disappointment and reproach upon the surgeon. The obstruction in these cases is not caused by a narrowing of the lumen of the intestine, but by suspension of the dynamic forces which propel the intestinal contents, and which result in accumulation of the fæces and gases in the paralyzed portion of the bowel, which is followed by distension of the intestines, constipation and obstinate vomiting which in rare cases may become fæcal. Circumscribed or diffuse paresis of the intestines is caused either by an inflammatory affection, such as peritonitis or enteritis, which produces suspension of muscular contractions in the same manner as when an inflammatory process in any other organ affects directly the muscular tissue, or the tunics of the intestines are in an intact condition, but a paralysis has resulted from reflex causes. Pitts* narrates two cases in which after reduction of a strangulated hernia he performed laparotomy on account of persisting symptoms, and found no cause for these symptoms save that presented by the free but lifeless coil that had been liberated too late.

The contents in a paretic bowel are liable to undergo fermentative and putrefactive changes and the gases which are developed during such changes accumulate and cause such an extensive tympanites that the latter may become a mechanical cause of obstruction.

1. *Tympanites.*—Cases of sudden death from obstruction of the intestines and stomach by rapid accumulation of gas have been reported by Dechambre, Mercier, L'Pereyra, and others. The patients were generally aged persons, or young persons during convalescence from protracted diseases.

Guéneau de Mussy† in a clinical lecture treats of the mechanical conditions which cause accumulation of gas in the intestines. Where no mechanical obstruction is present the gaseous distension is due to paralysis of the sympathetic nerves. The failure of the gas to be expelled is owing to the formation of numerous flexions from the over-distension and later to compression of some parts of the intestines by the distended loops. The lowest portion of the ileum may be compressed against the ascending colon so firmly as to become a cause of complete mechanical obstruction. Proof of the existence of such a mechanical condition is furnished in cases of extensive tympanites where the introduction of a rectal tube affords no relief. In such cases the distension increases even after death. The author has also furnished experimental proof. The cadaver of a child was inflated moderately through the œsophagus, after which the œsophagus was tied and a tube was introduced into the rectum and its distal end immersed under water. Pressure upon the abdomen expelled the air through the rectal tube. When he repeated the experiment, but carried the distension farther, no air could be made to escape through the rectal tube by compressing the abdomen. On opening the abdomen with great care, it was seen that the lower portion of the distended ileum was pressed against the ascending colon so firmly as to completely interrupt the communication between them. From these observations it can be readily seen how the formation of an intestinal anastomosis would frequently prove the means not only in relieving the obstruction, but also in the removal of its cause.

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* St. Thomas' Hospital Reports. Vol. xi., 1882, p. 75.

† Des conditions Mechaniques de la tympanite. Gaz. hebd., 1867, No. 31.

If gas is present in the peritoneal cavity as the result of putrefactive changes of the products of peritoneal inflammation, it presses the liver away from the diaphragm and the percussion dullness disappears completely when the patient lies on his back. In distension of the abdomen from the presence of gas in the intestines the diaphragm and liver are crowded upwards, but the latter remains in contact with the chest wall, and the area of liver dullness remains the same, but is displaced in an upward direction. Where life is threatened by tympanitic distensions of the abdomen during the convalescence from acute diseases the symptoms appear very rapidly and death results from mechanical compression of important organs. Puncture of the distended intestines followed by aspiration and if need be repeated at short intervals is positively indicated in most cases. There can be no doubt that in many cases of peritonitis attended by diffuse and excessive tympanites the symptoms which point to intestinal obstruction are due to the same causes, flexions and compression, and such cases would also be greatly benefitted and sometimes cured by the same treatment.

2. *Peritonitis.*—Peritonitis may lead to symptom resembling intestinal occlusion in different ways according to the extent and type of the disease. In extensive plastic peritonitis the immobilization of a considerable portion of the small intestines may give rise to persistent vomiting, and absolute constipation. Again, as we have just seen arrest of the fæcal circulation may be caused by the tympanites alone, while perforative peritonitis is attended by a local and general shock which causes intestinal paresis through the sympathetic nerves. Heusner* has observed that perforative peritonitis gives rise to disturbances simulating intestinal obstruction by arresting intestinal movements. He narrates the history of two cases of this kind where the symptoms of intestinal obstruction were so prominent that laparotomy was performed. In both cases, perforative peritonitis, but no occlusion, was found.

Henrot,† in his classical monograph on pseudo-strangulation describes a number of cases of perforation of the gall-bladder and the processus vermiformis where the symptoms during life had pointed so strongly to the existence of intestinal obstruction that a wrong diagnosis was made by able clinicians. He also calls attention to those cases of paralytic obstruction which are often observed after herniotomy and in cases of strangulation of the appendix vermiformis and testicle. The intestinal paresis, where it is not the result of inflammation must be looked upon as a reflex symptom.

Physical signs and symptoms are sometimes utterly inadequate to enable a distinction between acute intestinal obstruction and diffuse peritonitis. In differentiating between these two conditions it must be remembered that in the absence of a tumor absolute constipation and fæcal vomiting are the most characteristic symptoms of obstruction and that in peritontis the pain is severe and continuous, with diffuse tenderness, tympanites, and absence of visible intestinal coils. In mechanical obstruction of the bowels the temperature as a rule is not above normal unless complications have set in, while in peritonitis a rise in temperature is the rule although in some of the gravest cases it is subnormal. Many cases of supposed recovery of intestinal obstruction without operation undoubtedly were cases of dynamic obstruction, and the recovery was either entirely spontaneous or facilitated by means which assisted in the restoration of the peristaltic action. In 1851 a patient was admitted into Dupuytren's ward with well-marked symptoms of acute intestinal obstruction. This eminent surgeon gave it as his opinion that without an operation a fatal termination was inevitable, but the patient objected to the operation and was transferred to another ward, where he recovered in three days under the use of simple cathartics.

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* Deutsche Med. Wochenschrift, 1877.

† Des Pseudo-etranglement, etc., Thése, Paris. 1865.

Numerons similar cases could be cited in illustration of the difficulty of differentiating in all cases between mechanical occlusion and dynamic obstruction.

3. *Catarrhal and Ulcerative Enteritis.*—For some reasons which at present it is difficult to explain, simple catarrhal enteritis and circumscribed ulcerations of the small intestines have occasionally been the cause of rapid accumulations of gas followed by symptoms of intestinal obstruction. Mercier* has recorded a case where a patient died after a brief illness during which all symptoms pointed to the existence of intestinal obstruction, including complete constipation and fæcal vomiting. The necropsy showed no stenosis or any other form of mechanical obstruction, but several large ulcers in the middle of the ileum.

Mosler† reports a case of acute intestinal obstruction which followed a catarrhal enteritis, where on post-mortem no primary mechanical obstruction could be found. The small intestines were so enormously distended that they filled the entire abdominal cavity, compressing the ascending colon so firmly as to render it completely impermeable ; the transverse colon was also compressed, but to a lesser extent.

Zimmermann‡ described a case of acute intestinal obstruction, where during life the collapse came on so rapidly as to resemble cholera. The bowels remained completely constipated, and the vomiting was so severe and persistent that on the seventh day it became stercoraceous. The patient lived six weeks. At the necropsy the small intestines were found enormously distended and their walls were much attenuated. Colon was also distended. In the ileum a number of small ulcers were found which had destroyed the entire thickness of the mucous membrane. In a case of this kind, Obalinsky made a laparotomy and as he found the external surface of the lower portion of the ileum only congested, but no mechanical obstruction, he closed the external incision and the patient recovered. He believed that in this case there were typhoid ulcers which caused a functional stricture of the gut and the symptoms which induced him to open the abdomen.

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* Note sur deux cas d'ileus. Gazette Méd. de Paris, 1867, p. 151.

† Ueber den Ileus. Archiv der Heilkunde, 1864, No. 2.

‡ Ein Beitrag zur Lehre vom dynamischen Ileus. Canstatt's Jahresbericht, 1860, B. III., p. 245.

4. *Exventration.*—At a recent meeting of the Berlin Obstetrical Society, Olshausen reported several cases of laparotomy, in which more or less exventration became unavoidable during the operation. A few days after the operation the patients presented all the appearances of an attack of acute intestinal obstruction and death followed five to ten days after the operation. Olshausen explained the symptoms during life, and the fatal termination by assuming the existence of intestinal paralysis, distension of the bowel and absorption of toxic agents from the intestinal canal. During the exventration the intestines became engorged by venous hyperæmia, which in turn again is followed by exudation into the tissues of the bowel.

Sebileau * re-opened the abdomen in two cases of acute intestinal obstruction after laparotomy, and no mechanical occlusion or exudation of any kind, but enormous meteorism was found. He attributes this condition to intestinal paresis and rapid accumulation of gas. The prophylactic treatment of such cases is more important than the curative. The administration of a brisk cathartic on the second or third day after the operation will usually prevent tympanitic distension of the abdomen by stimulating the paretic walls to active muscular contractions, and by removing the intestinal contents the source of putrefactive changes. This treatment should never be postponed until the paralysis has been aggravated by over-distension, but should be resorted to either before or upon the first appearance of intestinal distension. Uniform compression of the abdomen with strips of adhesive plaster and bandage applied over the antiseptic absorbent dressing immediately after the operation should be kept up until all danger from the occurrence of tympanites has passed. When the distension has become so great as to threaten life, the treatment should consist of the employment of such prompt mechanical measures which will diminish the intra-abdominal pressure. As the stomach may also be dilated its contents should be removed through a flexible stomach tube, followed by an irrigation with a harmless antiseptic solution. Tubage of the colon followed by a turpentine enema is used for the same purpose. If these measures fail in relieving the distension a prompt resort to intestinal puncture with a fine hollow needle becomes imperative. This surgical resource may be repeated as often as it may become necessary to avert danger from an increasing intra-abdominal pressure.

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* De quelques accidents intestinaux survenant aprex les opérations abdominales. Annal. de Gynécologie, T. xxv., p. 118).

DISCUSSION ON INTESTINAL OBSTRUCTION.

PAPER BY

PROF. RAFAEL LAVISTA, of Mexico.

The able papers which have just been read, very properly dwell upon the importance of a clear diagnosis in each case, in order that accidents of a very grave character, which we are, as a rule, as powerless to avert by other means, may be controlled, if not averted, by a timely recourse to a surgical operation. Whether produced by ileus, strangulation in its various pathological forms, or by the presence of neoplasms, intestinal obstruction is, to a certain extent, characterized by certain symptoms which are, at first, common to all its forms. There are, however, other and special phenomena, whose careful consideration is of material assistance in forming a correct diagnosis. In all forms of the disease, there are two well-marked periods during which the indications appear to be precise and well determined. For instance, in certain cases of strangulation or obstruction produced by adhesions and bands, a sub-acute course is by far the most common. Yet, in equally chronic cases, so to speak, which are due to intestinal stenosis, resulting from an inflammatory or ulcerative process, we may find the obstruction suddenly ushered in by all the accidents which characterize the acute forms of the disease. The practitioner is, therefore, greatly puzzled in not a few cases, in forming a correct diagnosis. The two conspicuous symptoms in most cases of intestinal obstruction are pain, and the cessation of all intestinal functions. The occurrence of vomiting, at first, of matters ingested, then of bile, and later, of fæcal matters, is only met with, as a rule, in cases of obstruction of the small intestine, it may be said to occur earlier in the disease if the obstruction be situated high up. Here then is an important diagnostic point. The persistent hiccough met with in many cases is undoubtedly due, in my opinion, to an irritation of the diaphragm, resulting from the pressure of the intestinal distension. Fever never accompanies these phenomena in the earlier stages of the disease, a fact of importance in the differential diagnosis.

The second phase of the disease in its acute form, constituting the period of strangulation, is attended with nervous and septico-fecaloid symptoms. The former result from the great irritation of the solar plexus, which has been as aptly called the abdominal cerebrum. There is at first a period of stimulation, which is generally followed by a state of profound collapse. To this stimulation, propagated to the cerebral and medullary centers, more particularly the latter, are referable those disorders of circulation, respiration and calorification, usually attending the disease. These disorders of innervation are accountable for those remarkable cases in which perforation occurs without causing any elevation of temperature or other characteristic signs of peritonitis, the sudden change in the patient's appearance, the facies abdominalis, the extinction of the voice and excessive prostration alone giving the clue to the condition. Meanwhile, the intelligence and consciousness of the patient are quite intact, except in a limited number of cases, in which there may be some drowsiness and apathy.

The septico-fecaloid symptoms, that is to say, the complete suppression of all secretions, dryness of the mouth and nose, and the development of the typhoid state without pyrexia now in their turn make their appearance.

A point of great importance in the surgical management of the disease in question, is to ever keep in mind the fact that the intestinal walls, from the strangulation and over-distension, are no longer in a condition to resist the slightest traction, and must consequently be handled with the greatest care, lest during the exploration for the seat of the trouble, perforation take place. In one case under my care, in which I performed laparotomy as a last resort, incision through the abdominal walls having diminished the intestinal tension, was of itself sufficient to cause perforation. At the point where the intestine gave way, it was found to be very friable when seized between the fingers; this condition was obviously due to the local asphyxia. If the pathological anatomy of intestinal obstruction is of great interest, of greater interest still, in my opinion, is the determination of the precise moment when the symptoms of strangulation begin to develop. If this can be done the life of the patient may generally be saved by a timely operation; if not, there can be but little hope of relief by an operation when all the grave symptoms of strangulation have developed themselves.

Let us for a moment suppose that in a given case we have diagnosticated a stenosis in some part of the intestinal canal, due either to syphilitic infection (intestinal syphilosis), or, as is frequently the case in chronic alcoholic patients, to a parenchymatous enteritis with profound alteration of the muscular coat. In either of these cases, the indications which the practitioner must fulfill can admit of no discussion, and an immediate operation is justifiable. You are doubtless acquainted with the remarkable case of Prof. Kœberlé, who removed a portion of the small intestine two metres in length, from a patient suffering from intestinal stenosis, and had the satisfaction to exhibit his patient before the École de Médecine in a perfect state of recovery.

The diagnosis of intestinal obstruction in its varied forms is of extreme difficulty, and all the resources at our command, instead of elucidating the subject, frequently fail to afford definite information. This very uncertainty in the surgeon brings about a sort of timidity and hesitation to operate at the proper moment in a given case, and in another a fever of temerity. Alas, how many and grievous mistakes have been made in not interfering at the proper moment!

Permit me to call your attention for a moment to a certain form of intestinal obstruction, unfortunately not uncommon, which may be denominated as obstruction by dilation. In this form, which I consider is one of the most difficult to remedy, the dilatation is sometimes so great as to be capable of determining all the accident, of obstruction, while the diagnosis is by no means easy. While keeping in mind the probable necessity of an operation, the medical management of a case of intestinal obstruction should not be neglected. Pain should be assuaged at the earliest possible moment, for I am convinced that pain, of itself, can kill. In most cases, I have recourse to opium, in doses sufficiently large, not only to control the pain but also to paralyze the intestine and prevent any effort, on its part, to overcome the resistance offered by the obstruction, which effort is sure to increase the trouble. Opium is at once the best intestinal sedative, and the best preventive against peritonitis. But even this useful drug is not always sufficient, and it may be necessary to have recourse to the anæsthetic, chloroform, which produces, with certainty, absolute freedom from pain and the relaxation of the muscular tissue of the intestinal wall. I have never, in an extended use of the drug in such cases, seen any untoward result from its use, even when used continuously for over twenty-four hours. Under its influence, the careful exploration of the abdomen is greatly facilitated. Recourse may be had, the while, to large rectal insufflations or injections, and to digital exploration of the rectum, which is always of material assistance in the diagnosis.

I have made use, in some cases, of rectal injections of sulphuric ether, with some advantage; such injections rapidly alleviate the suffering. Still, they are not to be used indiscriminately, as they are dangerous and obviously, not easily controlled. They should, therefore, be used in extreme cases where all other means have failed to afford relief. Another method, which experience has taught me is a valuable one, is the refrigeration of the abdomen, which may be produced in the surest manner by the application of chloroform, or a mixture of this drug and morphia.

In speaking of the medical management of cases of intestinal obstruction, I have intentionally refrained from mentioning those purgatives, extolled by some, which, with rare exceptions, are positively injurious; I have seen mild, and even chronic cases transformed, by their use, into acute ones.

When all these means have failed to improve the condition, or allay the sufferings of the patient, recourse may be had, in certain cases, with a view to diminishing the vascular tension in the intestinal wall, to another mode of treatment, the puncture and aspiration of the intestinal contents, gaseous, liquid and solid. I recall one case, among others, in which immediate relief followed the aspiration of the bowel in the right iliac fossa; a considerable volume of gases was removed, together with 1500 grammes of liquid and semi-liquid matters. After this operation, there was no recurrence of the serious symptoms, and the patient fully recovered. Undertaken with proper care, this operation is devoid of danger, at least such is my experience with it. I do not hesitate to assert that it is one of the best means of treatment which we possess, in the cases of intestinal inflammation. Unfortunately, it is not always successful, perhaps because the intestine has lost its elasticity, or there does not exist free communication between its component parts, or, because the body of the patient, when the operation is attempted, is not in a position suitable to permit a free evacuation. All the methods of treatment which I have enumerated should be faithfully and carefully carried out, until the occurrence of the first symptom of internal strangulation, when all temporizing is inadmissible. The surgeon must then have recourse, unhesitatingly to either of the two methods which modern surgery offers in such cases, namely, the enterotomy of Nélaton, or the exploratory operation, after the method of Lawson Tait, that great apostle of exploratory incision, or that advocated by Prof. Kœberlé, of Strassburg. Having had quite an extended experience with each of these methods, I confidently aver that they are all equally useful. I need not dwell upon the necessity of strict asepsis or antisepsis in every case. The exploratory incision being made, the surgeon should as rapidly as is consistent with care and thoroughness, inform himself of the situation and nature of the obstruction and remove the cause, whatever it may be.

But let me not abuse your kindness and the courtesy extended to me by dwelling upon this theme. My only desire has been to furnish my humble tithe to the fund of general information on this interesting and important subject.

PAPER BY

Dr. Thomas G. Morton, of Philadelphia.

As the subject of obstruction of the bowels has been so thoroughly and systematically discussed by those who have preceded me, I shall not further trespass upon our time in order to say anything further as regards the various forms of obstruction or their diagnosis, but will only refer briefly to a question of treatment. I would, however, note in passing what seems to be the relative infrequency of obstruction of the bowels here as compared with England. Treves states that as many as 2,000 deaths occur annually from this cause in Great Britain.

I have received the following letter from Dr. H. F. Formad, Coroner's physician of Philadelphia, in reference to the frequency of fatal obstruction of the bowels.

> Dear Doctor: I have met with but very few cases of intestinal obstruction from other causes than hernia and malignant disease [in my post-mortem experience]. Unquestionably they must be rare as a fatal affection. Exclusive of cancer and hernia I have met with ten or eleven cases of fatal obstruction from pressure upon colon or rectum of either ovarian cysts or uterine fibroids, and with only three cases each of volvulus and intussusception. * * * The total autopsies which I have made as coroner's physician of Philadelphia for the past five years and as pathologist to various hospitals for ten years, number 6,000 in which the intestines were examined.
>
> Very truly yours,
>
> H. F. Formad.

Dr. Morris Longstreth, Pathologist to the Pennsylvania and Jefferson Hospitals of Philadelphia, writes me that his "experience is that intestinal obstruction, excluding tumor pressure, are comparatively rare. If I exclude also malignant growths of the lower bowel and also general peritonitis with universal adhesions, I should say it was a very rare condition."

Dr. Thomas H. Andrews, formerly coroner's physician, and for eleven years demonstrator of anatomy in the Jefferson Medical College, informs me that he has personally made or supervised upwards of 2,000 post-mortem examinations in the city of Philadelphia, and that in but a single instance has he found any bowel obstruction.

At the Episcopal and Women's Hospitals of Philadelphia there has not been performed a single abdominal section for obstruction of the bowels so far as I have been able to ascertain. I have gone over the records of the Pennsylvania Hospital for the past twenty-five years, and there is not recorded a single section for the relief of intestinal obstruction, although colotomy has of course been very frequently employed for the relief of various forms of stricture of the rectum and sigmoid flexure. One fatal case of obstruction from volvulus which I find amongst the vast records of that institution was so peculiar in its form that I may be permitted to briefly refer to it here.

A man aged thirty-five, white, contracted an obstinate diarrhœa in 1873, which lasted fifteen months, and was then followed by constipation, the stools being small and suggesting stenosis of the large bowel. He was admitted to the Hospital in 1875, having suffered for six days with marked symptoms of obstruction of the bowels, pain, vomiting and constipation. Five days later, after all remedies had failed to give relief, and when the vomiting had become stercoracious, lumbar colotomy was performed, but no evacuation followed and the patient died two days later of exhaustion. At the autopsy it was found that there had been a complete transposition of the large bowel so that the caput colli occupied a position in front of the spleen, in the left hypochondrium. From this position the large intestine pursued a downward course at the side of the spine under a fold of mesentery, and from the left inguinal region passed across to the right side ; the fold of mesentery here constricted the bowel which just beyond this point had been opened by the previous operation. By seizing the caput colli and intestine and lifting both together and then revolving them upon their axis until the cæcum occupied its normal position, it was observed that the constriction entirely disappeared. There were no evidences of peritonitis present.

In 1866 another patient was admitted having the usual symptoms of bowel obstruction and a tumor being present in the groin, a strangulated hernia was diagnosticated. Dr. Agnew operated but found no intestine in sac. The patient died of peritonitis and at the autopsy it was found that there had been an obstruction of the intestine caused by an adhesion between the vermiform appendix [which was twisted backwards and to the left] and a loop of the ileum. This adhesion, one-third of an inch thick and a half an inch long, bridged the ileum four inches above the valve, in such a way as to compress it against the spinal column, and to completely occlude it. The mucous membrane at the site of pressure was completely destroyed. In my personal experience I have never had a case of intestinal obstruction due to intussusception, volvulus, or foreign body, which required operation. I have however seen a case of acute obstruction of the bowels in which there was stercoraceous vomiting, which after two days recovered without operation, and the patient has continued in perfect health ever since. Recently in another private patient, a middle aged woman, there was constipation, uncontrollable vomiting, and rapid loss of strength. Here I performed abdominal section for exploratory purposes and found annular cancerous constriction of the ileum, with extensive deposit of the same in the liver. The operation effected a complete diagnosis but of course the woman eventually died. In 1865 I was sent for by my friend Dr. Josiah Reeves, of Medford, N. J., to see with him a case of intestinal obstruction. This case I believed to be amongst the very first operated upon for that disorder by abdominal section. The notes of the case, now for the first time recorded, are as follows :

James O'Neal, of Medford, aged fourteen, was taken ill with symptoms of peritonitis about the middle of January, 1865. This attack was followed after a lapse of two weeks by marked symptoms of intestinal obstruction. This not yielding to various treatments I was summoned. After making a very careful study of the case I determined that an opening in the bowel was the only chance that could be offered to the patient. Operation was consented to, and the belly was immediately opened laterally upon the right side. The abdominal contents were found hopelessly matted together and adherent and bathed in putrid pus. The ascending colon at a point just above the cæcum was brought to the surface and an artificial anus made. The patient was almost moribund at the time of commencing the operation and died very shortly after its completion. Post-mortem revealed the cause of the peritonitis to be a hitherto unsuspected ruptured ulcer of the stomach. The obstruction was due to constricting lymph bands at various points in the intestinal course.

Occasionally in the course of peri-cecal inflammation and abscess, the intestines become so paralyzed that more or less obstruction may occur, with associated symptoms which materially aggravate the pre-existing disease, indeed, may even in a measure obscure the diagnosis. Very recently [in July last] I performed a successful laparotomy for peri-cecal abscess and perforated appendix ; the bowel was firmly bound by the peritonitis which also gave rise to great impaction, and as the case might readily have been mistaken for one of acute bowel obstruction, I will give the history briefly :

J. W. C., seventeen years of age, usual weight 180 pounds, had severe attack of ileo-cecal pain sometime in November, 1887, while at school, which laid him up for three days, and in May last a similar but less severe attack. On July 4th he ate an enormous amount of peanuts and cherries, but felt no special inconvenience, save constipation for three days, when he experienced colicy pains, had a somewhat watery stool, and for two days there was some looseness of bowels associated with severe cramps. At this time he had great tenderness in the right iliac region and could not stand erect. I was telegraphed for on July 11th, but did not reach the patient until the 13th, when I found him in a most serious condition. Although he had symptoms of obstruction, yet the diagnosis of perforation of the appendix, abscess and peritonitis was made. The pain, violent variations of temperature and profuse sweating and profound exhaustion, indicated pus, while the previous history of attack of colic, and pain in the ileo-cecal region, all pointed to the appendix as the source of trouble.

I promptly made a lateral section, evacuated an abscess of considerable size, and soon came upon the perforated appendix, which was closely attached to the cecum its entire length. The end of the appendix had sloughed off, and in this disorganized tissue I found a large oval fecal concretion, which evidently was the cause of the disturbance. Two very large portions of omentum were so constricted by lymph bands that gangrene had occurred, and there was general peritonitis. The appendix was tied and cut off close to its cecal attachment; two large portions of the gangrenous omentum were removed, the abscess cavity cleansed, as were likewise the whole abdominal contents. The cecum had very múch the shape and feel of a sausage, firm and dark in color, and bound down as the result of inflammation. Thorough drainage of the abdominal cavity was secured by a rubber and a glass drain tube, the latter passing to the bottom of the pelvic cavity.

No attempt was made to approximate the wound, but its cavity was lightly packed with antiseptic gauze, with the usual dressing upon the abdomen.

The patient did fairly well after the operation, took food well, but there was no action of the bowels. Two days later he had marked temperature and great restlessness, passing water frequently and with almost constant desire to evacuate the bowels, but without succeeding in having a discharge, although laxatives were freely administered. In response to a telegram stating that the patient was desperately ill, my son, Dr. Morton, Jr., went to Williamsport, and upon examination discovered an impaction of fæces in the large bowel which extended from cecum to anus. After some twelve hours work with the rectal tube and irrigation the colon was cleared of several pounds of fæcal matter, and the patient's condition immediately became much improved and continued to do so steadily until convalescence took place. At the time of the impaction it was discoverd that fæcal matter was passing into the original wound and examination showed that the cecum had given away, for a gangrenous spot was found, about an inch in diameter, on the uppermost part of the exposed bowel. Subsequently the patient rapidly improved and is now in his usual health, although the wound of operation has not entirely closed but is quite superficial, and the bowel opening, now very minute, is rapidly closing.

The difficulty, indeed the impossibility, now and then, of making a diagnosis in even acute obstruction of the bowels is seen in the following acute and promptly fatal case :

John W., 45 years of age, walked to the Pennsylvania Hospital and was admitted Oct. 13, 1886. While working the day before was suddenly seized with pain in the abdomen ; this was followed by diarrhœa and vomiting. On admission temperature was sub-normal ; great pain in abdomen, located below the umbilicus, paroxysmal in character ; he had vomited some clear, watery fluid, but soon after admission this ceased, breath was foul ; symptoms of collapse soon appeared, belly became tender and slightly full, and he died fourteen hours after entering hospital. The autopsy showed intussusception of four inches of the ileum. Dr. Arthur V. Meigs, who had charge of the patient, tells me that obstruction was not even suspected, for there were no symptoms which even suggested such a condition.

In the operative treatment of obstruction of the bowels I desire to thoroughly indorse the importance of diagnosis in the first place ; and in the second, the equal importance of very early section as soon as it becomes evident that nothing is to be gained by the employment of less effectual measures, or when a diagnosis is not clear, or impossible to make out, and the patient has begun to fail. For I firmly believe it to be far safer to operate than to procrastinate, or trust in anodynes or purges. The dangers of modern abdominal section are not to be compared to the risks which we must assume in waiting ; indeed we are not justified in delay when we have the means in our possession to make an exact diagnosis, and resorting to appropriate meaures for relief. The chances of success, as borne out by all experience and statistics, are vastly enhanced by the early resort to operation.

Dr. Arthur Durham, of London.

" Mr. President, before I say anything in regard to the subject under discussion, I hope that you, Mr. President, and you, Gentlemen of the Congress, will pardon me for saying one or two words on what might perhaps seem to be an extraneous subject. It is simply this:

I wish to express the great pleasure that I feel in coming here among my American confrères and in meeting with such downright hearty hospitality and such cordial reception as I and my friends have met with. Gentlemen, it is to say this rather than to say anything else that I am on the platform to-night.

However, the subject before us is not altogether a strange one to me. It is a subject in which I have taken, and do take, and as long as I live shall take the greatest possible interest. It is possible that some of you may have met with a book called Quain's Dictionary of Medicine. If you look into that book, you will find that the article on intestinal obstruction was written by myself, and you may take this as documentary evidence that I take great interest in this subject. It is a subject in which surgeons must take an interest. In these cases, life and death depend upon our action. There is no class of cases more serious, more dangerous, or more urgently calling for prompt treatment, than these cases of intestinal obstruction.

With reference to the papers read to-night, I would say that I entirely agree with Dr. Fitz and I entirely agree with Dr. Senn, that the sooner the physician calls in the surgeon the better it is for the patient. If the patient is allowed to go on until the physician reaches the conclusion that there is nothing more to be done, then there is poor chance of doing anything more with prospect of benefit to the patient. The earlier the surgeon is called to decide whether or not he can do anything, the better. It often happens that the surgeon is able to relieve the patient without operation, but often, indeed, it happens that operative measures are the only resort.

I agree with Dr. Senn that surgical operation should be performed as soon as the diagnosis is made, if the conditions are such as to indicate the necessity for, and to warrant operation. But unfortunately the diagnosis in these cases is often extremely difficult. I know of no class of cases in which the diagnosis is more difficult. I go a little further than Dr. Senn and say that cases do arise from time to time in which we are justified in operating before we fully make our diagnosis, after we have made the broad diagnosis of intestinal obstruction. There is not so much difficulty in deciding that there is intestinal obstruction, but the difficulty is to determine the cause. I therefore say that cases do arise from time to time in which we are justified in proceeding to operate not only before we have made a complete diagnosis but in order to enable us to make our diagnosis as to the precise nature of the case. But then we must be prepared to follow out the indications which may present themselves. In regard to the question of diagnosis, I want to say this as the expression of my feeling. In my article before referred to, I refer statistically to two or three thousand cases, thus showing that I do not undervalue statistics. Dr. Fitz very properly gave us a large amount of statistical matter and showed that so many per cent. of the cases were due to one cause, and so many per cent. to another cause. What I want to impress is this, that in having to do with a case of intestinal obstruction we should not be influenced too much by the *probabilities* in diagnosing its cause. Statistical probabilities constantly mislead. What we should be guided by are not the statistical probabilities but the actual indications of that particular case. Every case is to be studied and judged on its own merits, and treated according to the indications before us. To say when we are called to a case that the probabilities are that this is a case of so-and-so, because in so many cases there are so many of this affection, is wrong and will constantly mislead. In trying to teach the students at Guy's Hospital, I say to them, you must not apply the results derived from collections of statistics to the particular case with which you have to do too rigidly. The chances in favor of one man may be as one to one thousand, while in another man they will be as one thousand to one.

Now with regard to the observations and the suggestions made as to treatment by Dr. Senn. I came here to learn and I confess that I have learned a great deal to-night. The use of hydrogen gas seemed to me to be something new. I would ask what would be the result if after blowing the patient up inside with hydrogen gas, he should happen to blow out, and the gas come in contact with a flame? Would there not be a blow-up outside? I do not see why hydrogen gas should be better than air. Of course, it is lighter than air, but I do not see why lightness should be of importance in the insufflation.

To go a little further in regard to the treatment of cases of intestinal obstruction : of course, the first thing is to determine, if possible, the seat of the obstruction. In cases of acute intestinal obstruction, in which there is reason to believe that the seat of the obstruction is in the small intestine, then I suppose that the proper treatment is, as soon as the symptoms are severe and urgent, even if we have not made an absolute diagnosis to open the abdomen, search for the cause and relieve it as best we can. On the other hand, when the indications are that the obstruction is in the large rather than in the small intestine, there is not the same degree of urgency in the large proportion of cases. Of course, the proceeding to be adopted must depend upon our idea as to the seat of the obstruction. Here I venture without the slightest hesitation to take issue with Dr. Senn. I take issue with him on this point. He said that lumbar colotomy is an obsolete operation. I beg to say this, whether it ought to be obsolete or ought not to be obsolete, I know as a matter of fact that it is *not* obsolete. It is an operation which is constantly performed, day by day. I can not tell you in how many cases I have performed it, but I can tell you that I have never performed the operation in any case in which I have had occasion to regret having done it. I have had cases in which I did not perform the operation in which I have had lasting cause to regret that I did not do so. Therefore, I say without the slightest hesitation, that the operation of lumbar colotomy is not obsolete, and as far as I know certainly will not be obsolete so far as I am concerned. I know no operation in surgery, with the exception of tracheotomy, in which the making a simple opening has brought about so much relief, so much prolongation of life, and such lessening of suffering. You have a case of cancer of the rectum or of the colon with obstruction. By lumbar colotomy you relieve the patient and enable him to go on with an unspeakable amount of comfort, which could not be afforded with equal safety by any other operation. The operation of lumbar colotomy is simple, easy and safe. The operation of cutting out the intestine or of putting in these little bone plates, would certainly be attended with more danger; whether they would be more successful or not, I can not say. Were I myself the subject of cancer of the rectum I should willingly have lumbar colotomy performed. Time does not permit, or I could tell you of many cases in which after the performance of lumbar colotomy the obstruction has been gradually relieved, and the patient has gotten well, and the colotomy wound has healed.

Now thanking you most heartily for your very kind attention and indulgence, I beg your pardon for having spoken so long.

Professor Thomas Annandale, of Edinburgh.

I must ask your kind forbearance for this reason, and I think a very good one: I have been tossing on the Atlantic for the past week and arrived only half an hour ago. Another reason is that I have not heard the papers which are under discussion. As I have been called upon to speak, I may very briefly give my opinion in regard to the treatment of intestinal obstruction.

I think that in connection with the consideration of the treatment of this condition, it is necessary to divide the cases into two classes, the acute and the chronic. In the acute cases I think that it is perfectly right that everything that medicine can do should be tried, but not persisted in too long. When these measures have been fairly tried for forty-eight hours and the symptoms are urgent, I say that the case belongs to the surgeon, and the sooner the surgeon opens the abdomen, finds the cause and if possible remove it, or when not possible to remove it, to form an artificial anus, the better.

In the chronic cases we may wait a considerable time, in fact we may wait until the symptoms become acute. If a case of chronic obstruction present symptoms of acute obstruction, it should be treated as a case of acute obstruction.

I have heard my friend Mr. Durham refer to lumbar colotomy. I may say that from my experience, more particularly in obstruction of the rectum, I have learned to perform inguinal colotomy, making the opening in the left inguinal region. This is not a more serious operation than lumbar colotomy and in the majority of cases is simpler.

I do not think that I can say more. There are other gentlemen who can speak more readily as they have heard the discussion.

I must say that it is a great pleasure for me to meet my friends on this side of the Atlantic. It has been my pleasure to meet many of my colleagues on my side. It has been my desire to come over here. I have done so and I am sure that I shall not regret it.

Dr. William M. Ord, of London.

I suppose I am called upon as a physician to express the general inability of that branch of the profession to deal with the subject of intestinal obstruction, and no doubt one must admit that the much larger aspect of the subject from the point of treatment and from the point of diagnosis is in the hands of the surgeon rather than of the physician. The function of the physician appears to be very early in the case, and I think in looking back over a large number of cases of intestinal obstruction, that his function mainly ceases when he concludes on the one hand that the case is one of what has been called dynamic, but which I should prefer to call physiological, obstruction; on the other hand, one of mechanical obstruction. For my own part, I must admit that there is often great difficulty in the diagnosis. In those cases where there is little pain or fever without signs of obstruction one hesitates as to the decision. Perhaps you will think me a little cowardly and wanting in self-reliance when I state that under these circumstances I am inclined to adopt the views of the first speaker and claim a little time. Most of you on referring to your cases of intestinal obstruction will find a good many in which there has been simple absence of the passage of fæces, or a good deal of vomiting and pain with absence of the passage of fæces, everything pointing to intestinal obstruction, but yet no tumor could be felt. In some of these cases time with the use of opium has been followed by complete relief after a longer or shorter interval. I have on several occasions examined a patient at night with signs of obstruction where no sign of local obstacle could be found, where arrangements had been made for operation in the morning, but where under the use of the narcotic, nature has given relief shortly before the time for the operation has arrived.

I agree with all of the speakers that when we have decided that there is mechanical obstruction, the patient must sooner or later go into the hands of the surgeon. I agree that the delay must be only a short one, and only a very reasonable one. Perhaps as a physician I would look with less complacency upon the operation of opening the abdomen. I have many times looked on at this operation and I have felt, and indeed often seen how serious it often is. When one is dealing with a person over fifty years of age, and would rather make the delay as long as possible to avert the dangers which with the greatest care and the best operators will commonly follow. As I said in the beginning, this is more a matter for the surgeon than for the physician. I merely put in a plea for a moderate delay on the ground of necessary imperfections in our diagnosis.

Sir William MacCormac will bear me out in some of these remarks. He and I have had many cases of intestinal obstruction to consider together and in many he has operated with success. In some the operation has been performed too late, not always by my fault, although occasionally so. In other cases which seemed most favorable, either by reason of early age or of advanced age, where the operation has been performed early with great care and with perfect surgical completeness, the results of the operation have not been as satisfactory as we might have hoped. It is this large proportion of necessary deaths that has made me somewhat of a coward in the matter.

In closing, Dr. Fitz, said :

I have but one word to say in conclusion. I think that all must be pretty well satisfied, from what has been said, that no one of the speakers is likely to change his opinion upon the spur of the moment. Whatever views have been given, you will have an opportunity of reading in full, and you will then be able to decide whether there is anything good, bad, or indifferent in them.

Dr. Senn, said :

You will all agree with me that a study of English literature, of English text-books and of English hospital reports, shows that our English colleagues are exceedingly conservative in the adoption of all new procedures introduced into practice. The time has long gone by when any theory or any method of operation should be accepted as final, as safe, as applicable until it has been tested and found reliable by a critical profession. I can assure our distinguished guest, Mr. Durham, that hydrogen gas injected into the intestinal canal *never* forms explosive compounds, as atmospheric air is never present in the intestines, and hydrogen gas is present in a normal condition of the intestinal canal. Rectal insufflation of hydrogen gas has been shown to be a safe diagnostic procedure by numerous experiments on animals, and it has proved safe, efficient and invaluable by clinical experience. In one of the first experiments made on man, I was the subject. I should never have submitted to such experimentation if the safety of this procedure had not been sufficiently established by experiments on animals.

In cases of gun-shot wound of the abdomen it not only demonstrates the presence of perforation, but it also furnishes material aid in finding the visceral wound and shows conclusively whether all of the perforations have been closed or not, as in the last case on which I operated in which there were twelve perforations. The last perforation could not have been found unless recourse had been had to this measure. Eleven perforations were found in the region of the ileo-cæcal valve and closed. The integrity of the intestinal canal was then tested with hydrogen gas. The gas continued to escape. The sigmoid flexure was then sought for and compressed but the gas continued to escape. By continuing the search in a downward direction I finally reached the last perforation in the rectum at a point where the peritoneum reflects itself from rectum to bladder. This perforation if left would have proved fatal. The patient is now doing well, a week after the operation. In a case of gun-shot wound of the chest, I had reason to suspect, on account of the obliquity of the wound, that possibly the stomach had been injured. In such a case it would have been criminal to perform laparotomy unless I was able to prove beforehand that some portion of the gastro-intestinal canal was injured. Insufflation of the gas through the stomach was practised and the gas was lighted as it escaped from the wound in the chest. Laparotomy was performed and two perforations were found in the stomach.

In my remarks on colotomy I did not mean to condemn the operation. I am in favor of the operation in all cases where the cause of the obstruction is in the colon or rectum and cannot be removed by a radical operation. The very colotomy is performed for the purpose of securing absolute physiological rest for the portion of the bowel at and below the seat of obstruction and to exclude it temporarily or permanently from the fæcal circulation. This cannot be accomplished by lumbar colotomy. If lumbar colotomy is not now obsolete in England it will be sure to be so in the near future, as a large experience on the continent has demonstrated the superiority of the inguinal operation.

Adjournment of Tuesday evening session.

CEREBRAL LOCALIZATION IN ITS PRACTICAL RELATIONS.

BY CHARLES K. MILLS, M.D.,

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While appreciating the honor of having been chosen to open a discussion upon Cerebral Localization in its practical relations, I am, at the same time, deeply impressed with the responsibility imposed by the choice. Difficulties beset my way; and not the least of these springs from the proportions to which the subject has grown. At the Seventh International Congress, in London, in 1881, the very existence of special cortical areas was under heavy fire; but the present discussion has been determined to other channels. In the few years which have elapsed since then great advances have been made, and while different interpretations of phenomena may be still worthy of argument, the guiding principles of localization are so firmly established that the physician and surgeon can use them without question for practical purposes—even to the extent of fearlessly invading with trephine and knife the deep recesses of the brain.

From the clinical and pathological observations of practical physical physicians sprang the great conceptions out of which have developed the science and art of localization. Gall,* from outward form and on uncertain grounds, located speech above the orbits; in 1825 its pathology and morbid anatomy were first clearly indicated by Bouillaud,† who held that in the anterior lobes of the brain resided the organ of speech; and Broca,‡ in 1861, from pathological observations, definitely placed the seat of articulate language in the gyre which bears his name. In 1864, J. Hughlings Jackson,§ suggested that certain convolutions superintended those delicate movements of the hands which are under the immediate control of the mind; and an observation of Hitzig* that certain ocular movements and other muscular phenomena occurred during the galvanization of the heads of patients, lead in 1870, to those researches with Fritsch, which have immortalized the names of both.†

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* Gall et Spurzheim, Anatomie et physiologie du systême nerveux. Vol. i–iv. Paris, 1810–1819.

† Traité Clinique et Physiologique de l'Encéphalite, p. 284.

‡ Bull. de la Soc. anat., T. vi. Aôut, 1861.

§ London Hospital Reports, vol. i., p. 459, 1864, and Clinical and Physiological Researches on the Nervous System.

In a national Congress it might not be out of place to review American work in localization; but time will permit me to recall only a few salient facts. The researches of S. Weir Mitchell‡ on the physiology of the cerebellum constituted an early and important contribution to encephalic localization. From numerous physiological experiments, chiefly on pigeons, both by methods of ablation and of chilling or freezing, he concluded that the cerebellum was a great reinforcing organ, capable of being more or less used in volitional muscular motion; but while believing this he was not prepared to assume that it had no other function.

In 1874, a committee of the New York Society of Neurology and Electrology, as the result of carefully recorded experiments, reported conclusions largely confirmatory of those announced by Hitzig. The committee tested also the effects of excitation of the dura mater.§

Dr. J. J. Putnam,‖ of Boston, in 1874, experimented with faradic currents on the cerebral cortex and the parts immediately beneath. He first found the centres for definite, and nearly or quite uncomplicated movements, and the minimal current strength that was necessary to produce these movements, after which, with a sharp knife he made a cut underneath these centres, leaving a good-sized but thin flap which contained these supposititious centres. Having done this, he found if he irritated as before, leaving the flap in situ, the movements did not occur. Turning the flap up, however, a slightly increased current strength produced the same muscular contractions. When the flap was turned back and adjusted, and the electrode applied on its surface as at first, the contractions were not produced. Three dogs were used in the experiments, which were made by Dr. Putnam at the Physiological Laboratory of the Harvard Medical College, with the assistance of Prof. H. P. Bowditch and Dr. William James. After they were made it came to Dr. Putnam's notice that from the same methods the same results had been obtained in the same year by another observer,

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* Untersuchungen über das Gehirn.

† Ueber die elektrische Erregbarkeit des Grosshirns. Reichert and DuBois-Reymond's Archiv., 1870, No. 3.

‡ Am. Jour. Med. Sci., n. s., vol. lvii., 1869, p. 336.

§ New York M. J., 1875, xxi., 225–240.

‖ Boston M. & S. J., 1874, xci., 49–52. Ibid. 1879, c., 260–262.

Braun.* Dr. J. Burdon Sanderson,† also, in 1874, had announced the same fact.

The first reported physiological experiments on the human brain were those of Bartholow,‡ in 1874, who, using both a galvanic and a primary faradic current, passed insulated needle electrodes into the brain of a patient.

In any historical reference to American work the labors of Wood§ and Ott‖ on thermic phenomena must hold a high place.

In 1884, Starr,¶ in a review of American medical literature for twenty-five years before, found records of nearly 500 cases of local disease of the brain, some of great value; such records have since increased and multiplied, and what is better, have improved in method and accuracy. The numerous contributions of Seguin here rank first. A brain tumor was removed by Hirschfelder and Morse,** of San Francisco, February 15, 1886, the fifth case of such operation. Of 63 cases of intracranial operations tabulated by Dr. Park, 17 have been reported by American neurologists and surgeons.

The surgical aspect of cerebral localization is naturally that which appeals to all as the most practical. In this field unprecedented therapeutic results have been achieved, the crowning triumph being the relief of that most agonizing of human diseases, tumor of the brain.

Fascinated by these achievements, we incline to pass by the results elsewhere wrought—in psychological medicine and medical jurisprudence; in general symptomatology and diagnosis; in medical therapeutics and technique. I may, however, be allowed to devote to these a few fleeting words.

Cerebral Localization and Insanity.

Bevan Lewis,†† in 1883, pointed out some of the directions in which studies in cerebral localization might advance our knowledge of insanity, but to those I can scarcely more than allude. He held that the localization of cerebral function was the outcome of the great principle of evolution carried to its logical issues; that the alienist should rivet his attention upon the changes undergone by the material substrata of mind; that he should strictly and closely study the objective manifestations of mental activity; that he should learn to examine the various limited lesions of the cortex as to area, depth, localized atrophy, relative bulk of convolutions, and tracts of ascending and descending degeneration.

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* Eckhard's Beiträge zur Anatomie und Physiologie, vii., 2. Also: Centralblatt. Berlin, June 13, 1874.

† Proc. Royal Soc., June, 1874.

‡ Am. J. M. Sc., Philada., 1874, n. s., lxvii., 305–313.

§ Fever: A Study in Morbid and Normal Physiology. Smithsonian Contributions to Knowledge. November, 1880.

‖ Jour. Nerv. and Ment. Dis., April, 1884. Philadelphia Med. News, July, 1885. Jour. Nerv. and Ment. Dis., vol. xiv., No. 3, March, 1887. Ibid. No. 7, July, 1876, p. 428. Ibid., vol. xiii., No. 2, February, 1888.

¶ Am. J. M. Sc., Phila., 1884, n. s., lxxxvii., 366–391.

** Pacific M. and S. J., San Francisco, 1886, xxix., 210–216.

†† Brit. M. J., London, 1883, ii., 624–628.

Numerous isolated cases have been reported in which special mental phenomena have accompanied lesions and defects localized in particular regions—cases of lesion of the frontal lobes with affection of the intellect; of other cortical lesions with disturbance of a speech and real or apparent mental impairment; of others with hallucinations, visual, aural, tactile, olfactory, and gustatory; of delusion, hallucinatory or otherwise, with arrested or aberrant development of fissures and gyres. In particular, a considerable collection of visual hallucinations and delusions with localized lesions have been reported. Sir J. Critchton-Browne,* Spitzka,† and others, have contributed valuable localization observations from studies in general paralysis of the insane.

Mickle‡ has shown that lesions of the cortical sensory centrea of the cerebrum are connected in an intimate way with the production of most of the hallucinations in progressive paresis; that from the cerebral localization point of view use may be made of the distribution of the cerebro-meningeal adhesions and the cortical changes associated therewith; and that in all cases of visual hallucinations the angular gyre is not affected in the marked manner one would anticipate, on the theory that it is the sole cortical visual centre; nor in cases of auditory hallucinations is the first temporal, viewing it as the sole cortical centre. The morbid anatomy of progressive paresis, he therefore believes, fails to support the exclusive view that these gyres are the sole centres of sight and hearing. The supra-marginal convolution is affected more than the angular in those with visual hallucinations, and the adhesions are often well marked on the posterior parietal lobule. The second temporal gyrus seems to suffer more than the first in cases with auditory hallucinations taken collectively.

Trephining has been performed in many cases of insanity during the last few years, a fair percentage of the operations having been guided at least in part by the principles of localization.

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* West Riding Reports, vol. vi., p. 170.

† Insanity: Its Classification, Diagnosis and Treatment. Article on Paretic Dementia.

‡ Jour. Men. Sc., Oct. 1881; Jan. and April, 1882.

Two of the recent cases of brain operation, reported by Bennett and Gould* and by Macewen,† open a possible new field for surgical interference in insanity. In the case of Bennett and Gould, the patient had received a violent blow on the right side of the head and had a scalp wound without apparent injury to the skull. Pressure on the cicatrix caused the sensation of a flash of light followed by unconsciousness for one or two seconds. The patient had no paralysis, loss of sensation, or other symptoms, but was subject to left unilateral convulsions with loss of consciousness, commonly followed by violent mania. The attacks were usually preceded by a bright red flash of light, and were succeeded by what appeared to be threatening visual hallucinations. The scar was over the region which corresponded with the angular gyre. A large trephine opening was made by Mr. Gould, bone and dura mater were removed, and exploration was made in different directions in the brain, but nothing abnormal was detected. Five months later the patient was apparently well having had no attack during that time, although for six years before he had had on an average one fit a week. After his recovery he seemed to forget all about the hallucinations. Dr. Bennett in another case, observed similar hallucinatory phenomena, and after death the angular gyre was found to have been injured. Such cases are of importance as opening the question of the propriety of excising cortical areas as a method of treatment in insanity as well as epilepsy, when certain subjective phenomena such as hallucinations of sight and hearing can be given a local habitation in the brain.

Macewen's case was one of psychical blindness. The patient had received an injury about a year previously and suffered from deep melancholy, and strong homicidal impulses directed against his family and relieved by paroxysms of pain in the head of indefinite seat. Prior to receiving this injury he was perfectly free from such impulses and had led a happy life with his family. Behind the angular process was a slight depression, which could not account for his symptoms. No motor phenomena were present, but on minute inquiry it was discovered that immediately after the accident and, for about two weeks subsequently, he had suffered from psychical blindness. The angular gyre was exposed for operation, and it was found that a portion of the internal table of the skull had been detached from the outer, and had exercised pressure on the posterior portion of the supra-marginal convolution, while a corner of it had penetrated and lay imbedded in the brain. The bone was removed from the brain and re-implanted in proper position, after which he became greatly relieved in his mental state, though still excitable. He made no further allusions to his homicidal tendencies.

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* Brit. Med. Jour., Jan. 1, 1887.

† Lancet, August 11, 1888.

Cases of double personality and double consciousness, and of unilateral hallucination, like the following reported by Magnan,* may eventually receive their proper interpretation through investigations in localization. Magnan holds that there are hallucinated individuals who hear on one side agreeable things and on the other side unpleasant. He had had under observation four cases of this kind, of which one was reported in detail. The case was one of primary monomania, complicated with epilepsy. On the right side disagreeable statements were made; on the left ambitious ideas were conveyed. These latter hallucinations were obviously secondary to the first. He concluded, first, that these unilateral hallucinations on opposite sides were independent of local lesion; that they did not differ from other hallucinations; that they proved the double action and functional independence of the two hemispheres; that analogous phenomena were noticed in hypnotic states; and that their existence demonstrated the action of separate sensorial centres in the cortex.

Contributions of Cerebral Localization to General Medicine and Therapeutics.

The vast improvements in precision both in examining and describing the symptoms of nervous disease; and in making and recording the results of autopsies have been largely due to the stimulus to exactness which has been given by the science of cerebral localization which has at its very foundation topographical precision.

The contributions of cerebral localization both to general and local symptomatology, if carefully brought together, would furnish material for an elaborate address. A flood of light has been thrown upon the nature of epilepsy, or rather epilepsies. Many old differential symptoms, some of them once regarded as pathognomonic, have been swept away, and better and surer criteria have been substituted in their place. The clinical teacher no longer announces that unconsciousness is the one sure sign of epilepsy, and the preservation of consciousness of hysteria; but the question of consciousness becomes a relative one in the consideration of both diseases. We are slowly getting the data for a really scientific classification of epilepsy into reflex, toxic, cortical, bulbar, and spinal. As Mr. Horsley has recently shown, it is no longer necessary to consider hystero-epilepsy, epileptiform seizures, laryngus stridulus, and eclampsia as altogether apart from epilepsy.

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* Journal de Médicine de Bordeaux, Sept. 30, 1883.

Not a few symptom-groups or symptoms formerly not understood at all, and some of them regarded as independent diseases, have been given their proper positions; such affections, for instance, as athetosis, tetany, and some spastic diseases of children. Vagueness has given place to clearness with reference to such affections as cerebral softening; and new light has been thrown upon such common and important diseases as tubercular meningitis, particularly as it affects the convexity of the hemispheres.

Now and then a new experiment or observation on cerebral localization has let in the light upon some obscure symptom or condition known to the physician. That peculiar perversion of sensory localization known as allochiria was noticed, for instance, by Horsley and Schäfer,* as the result of lesions produced by them in the limbic lobe.

Something has been accomplished with reference to the action of drugs on localized cerebral areas. I might point to the investigations of Albertoni † as to the augmentation of the excitability of the cortex by atropine, and the action of bromide of potassium in reducing the same excitability, a conclusion which has since been confirmed by Rosenbach and others, and is in accord with all clinical experience; to the work of Luciani and other Italian observers on chinconidine and pyrotoxine as epileptogenic agents; and to the experiments of Tamburini, Seppilli, Hitzig, and Franck into the effects of anæsthetics and narcotics on critical areas. Franck‡ has thoroughly investigated the effects of curarization on cortical excitability, and some of his results may prove of medico-legal importance in the study of masked or hidden epilepsy. Danillo, Magnan, and Franck have made important observations on absinthine epilepsy.

Experiments and discoveries like those of Eulenberg and Landois,§ Wood,‖ Ott,¶ Richet,** Aronsohn and Sachs,†† Wood, Reichert and Hare,‡‡ and Girard,§§ on the existence and phenomena of heat centres in the brain, have been of practical value in throwing light on the mechanism of fever, and on the action of special drugs and different modes of treatment on forms of high temperature. I will refer very briefly to some of the experiments and inferences of these observers, simply to show their practical tendencies.

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* Phil. Trans. Royal Soc. of London, vol. clxxix, (1888), B. pp. 1–45.

† Cortical Epilepsy. Experimental Researches. Synthetic Review. By Greuseppe Seppilli, M.D., Alienist and Neurologist, January, 1885. Translated by Joseph Workman, M.D., from the Rivista Sperimentale, 1884.

‡ Leçons sur les Fonctions Motrices du Cerveau, Par le Dr. François-Franck, Paris, 1887.

§ Compt. rend. Acad. de Sc. Par., 1867, lxxxii., 564–567. ‖ Op. cit. ¶ Op. cit.

** Bulletins de la Société de Biologie, March 29, 1884.

†† Deutsche Medicinische Wochenschrift, No. 51, 1882, and Pflüger's Archiv.

‡‡ Therapeutic Gazette, vol. ii., 3 s., No. 9, September, 1886, p. 577.

§§ Arch. de Physiol., norm. et path., Paris, 1886, 3 s., viii., 281–299.

Wood, for instance, holds that with the facts of his experiments in mind, the theory of a causation of fever becomes very plain. "It is simply a state in which a depressing poison or a depressing peripheral irritation acts upon the nervous system which regulates the production and dissipation of animal heat; a system composed of diverse parts so accustomed to act in unison continually in health, that they become as it were one system, and suffer in disease together. Owing to its depressed, benumbed state, the inhibitory centre does not exert its normal influence upon the system, and consequently tissue change goes on at a rate which results in the production of more heat than normal, and an abnormal destruction and elimination of the materials of the tissue. At the same time the vaso-motor and other heat dissipation centres are so benumbed that they are not called into action by their normal stimulus (elevation of the general bodily temperature), and do not provide for the throwing off of animal heat until it becomes so excessive as to call into action by its excessive stimulation even their depressed forces. Finally, in some cases of sudden and excessive fever, as in one form of so-called cerebral rheumatism, the enormous and almost instantaneous rise of temperature appears to be due to a complete paralysis of the nervous centres presiding over heat production and dissipation."

Girard,* as the result of certain experiments on rabbits, concludes that the cerebral centre of thermo-genesis is in the corpus striatum. Lesion of the median portion produced well marked increase of heat, and this was not the result of spasm of vaso-constrictor nerves of the skin. Exciting the region electrically caused a notable increase of heat, showing that this resulted from excitation and not from paralysis. Similar excitation caused increase of urea, indicating an increase of combustion in the organism, which was accompanied by considerable emaciation. Girard believes this apparatus or centre increases the heat under excitation, and notably influences the regulation and production of heat; also that artificial increase of heat is not identical with that of fever. Increased production, and at the same time diminished dispersion of heat, from the body are, according to his view, the two conditions essential to fever.

One of the latest contributions of Ott is on the heat centres of the cortex cerebri and pons varolii. He found that when in his experiments upon rabbits, a puncture was made just in front of the ear into the cortex, there ensued a fugitive rise of temperature ; and this observation led him to try in cats the effects of removal of areas of the cortex in this and other regions. A point at the juncture of the supra-Sylvian and post-Sylvian fissures was found to have the highest thermic value. Other parts of the brain, with the exception of the cruciate centres, had but small effect upon the temperature. The rise of temperature after injury to the Sylvian centres was from three to four degrees, and continued till the death of the animal, which was usually about the fifth or sixth days. The calorimetric investigations showed that either immediately, or at the end of twenty-four hours, the heat production and heat dissipation were increased ; after that they usually fell below normal, although the temperature remained elevated, with a weight decreasing daily. He believes that this increase of heat production was not due to secretory changes ; as pulse and pressure both rose for a short period, and then fell to a certain extent below normal, although the temperature was then rising.

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* Gazetta Degli Ospitali, Aug. 17, 1887.

The mechanism of temperature production, according to Ott, is : (1) Thermotaxic centres, cruciate and Sylvian of Eulenberg and Landois ; (2) Thermotaxic and thermo-genetic centres—the centre about Schiff's crying centre, and the extra striate, (Sachs and Aronsohn), and the thalamic centres ; (3) Thermogenetic centres—spinal centres.

"It is probable," says Ott, "that after injury to the cortical heat centre, the basal and spinal thermogenetic centres are temporarily permitted to obtain the upper hand, but that shortly the other cortical heat centres bring the thermogenetic centres into subjection, and thus reduce the heat production. In the case of lesion of the basal and spinal thermogenetic centres, for a short period they primarily overcome the cortical centres, but finally succumb to the domination of the thermotaxic centres of the cortex. In other words, the Sylvian and cruciate centres constantly antagonize the basal and spinal thermogenetic centres. It is also probable that under certain impulses the cortex and basal centres combine together to antagonize the spinal thermogenetic centres. It would seem that an injury to the thermotaxic or thermogenetic apparatus sets up a fever which is primarily accompanied by increased production and dissipation ; but they soon fall below normal, whilst the fever continues till the lesion is repaired. This would lead to the belief that in continued fever the generation of a ptomaine is continuously carried on for some time, and thus keeps up the fever."

Scarcely anything as yet has been contributed by these investigations to the surgical aspects of the question ; but a case reported by Mr. Page* has at least some suggestive value, and is the only one to which I will allude. A man, from a fall, had a wound one inch in length in the right parieto-occipital region. He was put to bed and became dull and apathetic; his temperature rose until it had reached 105° F., but otherwise he presented no symptoms that could be determined. Trephining was performed over the posterior part of the temporo-sphenoidal lobe. The patient's high temperature rapidly subsided and he recovered without other symptoms.

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* Lancet, London, 1887, ii., 1216.

Before leaving the consideration of these questions of general symptomatology and therapeutics, it might be well briefly to refer to what has been accomplished in cerebral localization with reference to some of the organic or involuntary functions. Are there circumscribed localized areas in the cerebrum which are capable of producing certain so-called organic or involuntary effects, or effects which may be classed as somewhere between the purely voluntary and the involuntary? In other words, to put the question in its simplest expression, have we centres—comparable to those which give definite motor reactions—for such functions as those of respiration, heart-action, vascular tone, oculo-pupillary movements, the secretion of sweat, saliva, and bile, or the excretion of urine? No one has studied this subject with the thoroughness and originality of François Franck in his great work on the motor functions of the cortex, to which reference has already been made. His conclusions are based chiefly upon the results of irritation of various regions of the brain. He found excitation of the brain in various regions of the cortex efficient to produce organic and partly organic manifestations, but such areas were not circumscribed and invariably the same. Changes in respiration, arrest or increase of the movements of the heart, flushing or paling more or less local or general, suppression or increase in the flow of saliva, sweat, bile, urine, etc., could all be brought about by experimenting upon the cerebral cortex of dogs and monkeys. Such results, however, he does not believe should be regarded as simple reactions comparable to the definite movements caused in face or limb by irritation of the centres assigned to these parts. They are complex results more comparable to the reflex effects produced from irritation of sensory surfaces anywhere. He shows that the suppression of the cerebral region, whose excitation so clearly produces organic effects, does not cause the loss of the function put into action by the excitation.

These views are probably correct, in the main, although they may receive some modification with increase of knowledge upon this subject. Regions of the brain in the process of evolution have been differentiated into definitely localized centres of representation in proportion as the functions represented have become more and more volitional, more and more under the control of the individual. We can never probably have localizations for organic manifestations which will be available, for instance, for the purposes of the surgeon. A closer and fuller study may show the truth to be largely the same even for the so-called thermic or heat centres. It is altogether doubtful whether we have distinct vaso-motor cortical centres comparable to the simple centres for motion. In reference to this question, Franck says that all localizations of this kind ought to be renounced. The cortical surface, he says, agrees in a certain degree with the sensory surface, and does not contain the vaso-motor centres any more than the organic centres, whatever they may be ; the cortex fills the roll of separation, and not that of a productive organ of visceral reactions. The true vaso-motor centres are contained in the bulb and spinal cord. They receive the cerebral excitations as they receive the peripheral excitations, and react in both cases in a reflex manner in consequence of a similar mechanism.

Such localizations as those of Christiani* of higher respiratory centres must not be regarded in the same light as motor, visual and other independent simple localizations. This investigator, as the result of a series of experiments on rabbits and dogs, believed that he had found higher respiratory centres, three in the basal ganglia ; first an inspiratory one, chiefly reflex, at the bottom of the third ventricle ; second, one, also inspiratory, at a point between the anterior and posterior corpora quadrigemina ; third, an inspiratory and inhibitory centre at the entrance to the aqueduct of Sylvius. He also discovered, anterior to the inspiratory centre in the third ventricle, a coördination centre.

To speak of emotional centres in the same sense that we do of motor, visual, or auditory centres, is also unphilosophical. In certain organic brain lesions, says Pontoppidan,† emotional manifestations such as laughing or crying appear without a cause ; or an emotional cause produces undue effects, a pain, for instance, produces laughter. Such symptoms are usually met with in disease of the pons and oblongata. The investigations of Pontoppidan seem to show that the centres affected in such cases are those in the vicinity of the vaso-motor centre in the pons. He describes in detail three such cases. In the first, any question caused the patient to laugh ; in the second, laughing or crying occurred indiscriminately when any attempt at conversation was made by the patient; in the third, fits of laughter occurred without any apparent cause—the mere entrance of any one into the room would produce one. In two of these cases autopsies showed the existence of apoplectic clots in the crus cerebri and pons Varolii, and other symptoms of pons disease were present.

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* 36 DuBois Arch., 1884.

† Centr. f. Nervenheilk., 1887.

In the nervous wards of the Philadelphia Hospital are several cases similar to those described by Pontoppidan, other symptoms pointing also to disease of the pons. Such facts, however, do not indicate the existence of a special centre for emotion, comparable in any true sense to the circumscribed centres of the cerebral cortex; but rather point to the fact that in the pons-oblongata we have crossing and interblending the various tracts, ascending, descending and transverse, which unite the higher regions of the nervous systems to those lower centres which energize the nerves and muscles concerned in the expression of emotion, or join together these lower centres and the cerebellar hemispheres.

Cerebral Localization in its Relations to Surgery.

Let me now turn to the surgical aspect of this great subject—the surgical aspect in so far as it concerns the neurologist; it is upon this that the attention of the medical world is riveted to-day.

In this portion of my remarks, I will consider (1) the forms of disease and injury in which cerebral localization is a valuable aid to diagnosis; (2) the parts of the brain accessible to surgical interference, and the topographical diagnosis for these accessible areas, with some sources of error in diagnosis.

The neurologist is now constantly called upon with the surgeon for the relief of intra-cranial affections long held not to be amenable to treatment, and scarcely worthy, from a practical point of view, of diagnosis. My remarks must be chiefly concerned with questions of diagnosis.

Examination of medical literature shows that operations upon the brain, guided by localization, have been for tumor, cyst, fracture, abscess, hemorrhage, and discharging cortical areas.

Brain Tumors.

It may be broadly affirmed that brain tumors should be removed by operation when their exact position can be diagnosticated, when they are in accessible areas, when they are solitary, and when they are not of enormous size. Of Dr. Park's 63 cases, 11 are cases of tumor, and 12 of cyst; of 17 operations by American surgeons, 5 have been for tumor. In this connection I will only stop to give some facts and draw some inferences from personal experience; it is often wise to review personal experience even if in so doing we sometimes awaken vain regrets. I have notes of 20 cases of brain tumor with autopsies, most of which have already been published in some form. Hale White's* cases numbered 100; and Seguin and Weir,† combining the statistics of White and Bernhardt, tabulated 580 cases. Twenty cases are comparatively few, but such a list has the advantage of thorough personal knowledge. Of these 20 cases the locations were as follows: Prefrontal lobe, 2 cases; posterior portion of second frontal gyre, 1 case; motor (Rolandic) zone, 6 cases; superior parietal lobule, 1 case; temporal lobe, 2 cases; cerebellum, 2 cases; mid-base and corpus callosum, 1 case; pons-oblongata, 4 cases; optic thalamus, 1 case.

Twelve out of the 20 cases were in areas accessible to operation; one of the accessible cases was multiple. Of the 11 accessible cases left, 4 were fibromata, 3 gummata, 2 tubercular, 1 a carcinoma, 1 a glioma with intercurrent hemorrhage. In neither of the 2 tubercular cases would operation have been successful because of the diffusion of cerebral tubercular disease. The carcinoma and glioma would probably have given only temporary success. Of the 7 cases left, all could probably have been removed successfully by operation at some stage of their growth; although in 3 of the cases, at the time of death, the tumors were of such size, and the break-down of brain-tissue in their neighborhood was so great, that the operation then would probably not have resulted in success. In at least 4 of the 20 cases, operation at any time before death would, in all probability, have been wholly successful. Is it any wonder that vain regrets for lost opportunities sometimes arise?

I favor the removal of old gummata, and this opinion is based upon considerable experience. Again and again I have seen such growths resist the most active and persistent anti-syphilitic treatment. It is probable that one reason why they will sometimes not yield to medicinal means is because in the progress of their growth they have obliterated blood vessels and become practically inert foreign bodies. Bergmann and White oppose, and Seguin favors the removal of gummata.

Cranial Fractures.

Localization rules are sometimes of value, even in cases of visible and easily detectable fractures, with lacerations, scars, clefts, depressions or ridges. These rules may be called in to clear up obscure points. Often in cranial fractures the extent of unseen damage cannot be told by the position and character of visible lesions. Numerous cases have been reported in which the operators would have been misled by trusting to external evidences alone; but in which by calling in the established facts of localization to assist they were able to place the trephine over the best spot for operation. Examination of surgical literature also shows that in many cases, demonstrated by autopsies, if the rules of localization had been properly applied, the site of hidden fractures either of the internal table or not, could have been determined and operations performed to the great benefit of the patient.

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* Guy's Hosp., 1884–85, 3 S., xxviii.

† Am. Jour. Med. Sci., July, August and September, 1888.

The best point for trephining in cases of fracture is not always the place of the greatest depression or cleavage, or over the centre of a large scar. In fracture cases the symptoms of dural irritation will often be prominent, and, particularly when the injury is over the motor area, may confuse the picture of spasm which is presented. The spasm may be dural or reflex, rather than cortical, or may have a mixture of reflex and cortical characteristics; and hence may be on the same side as the lesion or general, and thus involve the mind of the diagnostician in some doubt. An abscess resulting primarily or secondarily from a fracture may be so situated, or may have so enlarged, that localization rules alone can determine the best site for trephining. According to Jacobson,[*] out of 70 cases of middle meningeal hemorrhage a fracture was present in 62; so that in the majority of instances both fracture and hemorrhage must be taken into account.

Intra-cranial Abscess.

The question of intra-cranial abscess as well as fracture will be fully treated by Dr. Park and I will therefore say but little about these subjects. The cases of abscess in which localization rules have given the most brilliant results have been those in which without external evidences, a position for operation has been fixed. Several brilliant operations guided by cerebral localization have been recently reported, one of the most striking of these by Ferrier and Horsley.[†] This patient first complained of pain in the left ear, later a discharge, first clear and then of blood occurred. He became stuporous, had pain in the left side of the head, forehead, and back of the eyes, and photophobia. Later he became delirious and showed relative weakness of the right side of the face, a peculiar form of aphasia, and slight paresis of the right upper limb especially of the hand and digits. He had well marked optic neuritis, with a small hemorrhage over the right disc, and a small band below that of the left. His speech disturbance was peculiar. He was able to sit up in bed and talk, but his words were incoherent and for the most part unintelligible. He appeared to understand simple questions, but at other times seemed confused and unable to understand. He called things by wrong names. When asked to read a few sentences from a journal, the words he uttered had little or no resemblance to those before him. In addition to the involvment of the auditory centres there was probably here also a fracture between the receptive and emissive speech regions. Mr. Horsley operated for the locality determined by Dr. Ferrier and himself; about five drachms of pus were removed and the patient recovered. Dr. Ferrier refers to other operations reported by Gowers and Barker, Greenfield, Schondorff, and Truckenbrod, the first two having been cases of abscess in the temporal lobe diagnosticated without external indications.

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[*] Guy's Hosp. Rep., 1884–85, 3 S., xxviii, 147–308.

[†] Brit. Med. Jour., March 10, and March 24, 1888.

Intra-cranial Hemorrhage.

In a large number of cases of intra-cranial hemorrhage trephining has been performed, successfully or unsuccessfully. I have collected many of these cases, but cannot refer to them here except in the most general way; they constitute in themselves material for a lengthy paper. During recent years some important operations for such cases of hemorrhage have been guided by the principles of cerebral localization. Dr. J. B. Roberts, of Philadelphia, in his monograph on The Field and Limitation of the Operative Surgery of the Human Brain, of American authors has most thoroughly discussed the questions of operative interference in these cases of intra-cranial hemorrhage, as well as in fractures, abscess, tumors, and other lesions.

Intra-cranial hemorrhage may be (1) supra-dural; (2) sub-dural; (3) cortical or sub-pial; (4) intra-cerebral, that is, into the basal ganglia, capsules, or both, or into the centrum ovale. The first two forms are commonly due to lesions of the meningeal arteries, chiefly the middle meningeal, and are frequently associated with fracture, and occur from injury. Cortical or sub-cortical hemorrhage has its source in the cerebral arteries proper, most frequently in the cortical system of the middle cerebral.

These cerebral arteries have also a central or ganglionic system of branches, independent of the cortical, and it is from this arterial network that the ganglionic or capsular hemorrhage occurs. Hemorrhage into the centrum ovale may occur from the terminal vessels of either the cortical or ganglionic system.

Hemorrhage from contre-coup often calls for the application of the principles of localization. In cases of contre-coup the lesion, however, is often a form of bruising of the brain and its membranes with but little hemorrhage, for which trephining would be of no especial service, and it is important to distinguish such cases from those in which a genuine hemorrhage is present.

The forms of hemorrhage most amenable to topographical diagnosis and operative procedure are from the meningeal arteries proper and from the cortical system, that is, supra-dural, sub-dural and cortical. True cortical hemorrhage is comparatively rare, and meningeal hemorrhage comparatively frequent. Sometimes, instead of coming directly from a meningeal artery, the bleeding may be from the diploe of the fractured skull.

According to Kronlein,* the most frequent site of intra-cranial hæmatoma is the middle fossa of the skull, such lesion being usually limited in front by the lesser wing of the sphenoid, and behind by the margin of the petrous portion of the temporal bone, because of the adherence of the dura mater at these places ; below they reach nearly to the foramen spinosum, and above to the squamous suture, sometimes crossing the latter. The effusion is always thickest at the site of the rupture.

The symptoms of middle meningeal hemorrhage and supra-dural clot are both general and localizing. The general symptoms are such as loss of consciousness, and, in cases of traumatism, an interval of consciousness before the appearance of pressure symptoms ; change in temperature, usually elevation ; somnolence, stupor or coma ; slow pulse, sometimes becoming frequent at last ; slow, labored respiration ; vomiting. A small hemorrhage may give rise to few, if any, serious general symptoms.

Supra-dural Hemorrhage.

The symptoms of extravasation, when the hemorrhage is supra-dural are chiefly general. Contra-lateral paralysis, however, when the bleeding is over the motor area, may serve as a broad localizing indication when external appearances are wanting. Certain other phenomena are also usually present.

Unilateral affection of the pupil is often a sign of the utmost importance, particularly if, says Jacobson, one pupil is found widely dilated, the other being natural or contracted in size, and if the dilatation be on the side of the face corresponding to the injured side of the head. Mr. Jonathan Hutchinson has particularly studied and discussed the importance of this valuable symptom, and in honor of him Jacobson proposes to call it the "Hutchinson pupil." Hutchinson regards the symptom as due to direct or indirect compression of the third nerve. The pupils also furnish valuable indications as to the probability of recovery. The more dilated, insensitive and immovable they are, the less favorable the prognosis.*

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* Quoted by Jacobson.

Of the many cases of supra-dural extravasation which have been reported, in very few have the symptoms been studied closely.

Sub-dural Hemorrhage.

Sub-dural, or intermeningeal hemorrhage, if extensive, gives general symptoms much like those which are present in supra-dural clot, namely, loss of consciousness, changes in temperature, pulse and respiration, vomiting, etc. A sub-dural clot will usually to a greater or less extent bruise, and possibly even tear the brain surface. Spasm due to irritation of the motor cortex may be present, as well as dural or reflex spasm. Paralytic symptoms will be definite and pronounced if the lesion is in the motor region. Cheyne-Stokes breathing may or may not be present. The following are condensed notes of three out of a number of cases of this kind, of which I have collected the histories.

The first is a case of unilateral meningeal hemorrhage with contra-lateral symptoms, reported by S. N. Townsend Porter.† The patient was a woman admitted to the hospital unconscious, with Cheyne-Stokes respiration, which became stertorous and puffing. Paresis of arm and leg on left side, mouth slightly drawn to the right side, and left naso-labial fold almost obliterated.

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* Recently I had the opportunity of seeing an instructive case of supra-dural clot in the Philadelphia Hospital, in the wards of my colleague, Dr. F. X. Dercum. I will only refer to the case briefly, as it will doubtless be more fully reported by Dr. Dercum. The patient was a plethoric young man who came into the hospital without history, having been found in a stable insensible. Temperature, 95° F.; respiration stertorous —in breathing only the right nostril dilated and the right side of the mouth puffed; pulse weak, intermittent. The patient was insensitive to all impressions. Both arms and legs were spastic; the former drawn upwards and across the chest; the latter extended, the feet turned somewhat inwards. Occasionally jerking movements of both arms occurred. The head turned toward the right; the right pupil was dilated and dilating while the patient was under my observation; there was also right external strabismus. The patient died a few hours after these observations were made. The autopsy showed a bruised appearance of the skin about an inch above and to the right of the occipital protuberance. No depressed fracture was present, but a slight cleavage of the external table of the skull, and an extensive radiating or stellate fracture of the inner table. An immense supra-dural clot was found covering the lateral aspect of the parietal, and largely of the occipital lobe. The clot was back of the motor area.

† St. Louis Med. and Surg. Jour., 1887, vol. lii., p. 76–78.

Only moved the right extremities ; the head turned toward the right. Feeble convulsion lasting three minutes at night. Both sides affected, but left much less so than the right. Next day head and right eye showed marked deviation to right side. A clot was found between dura and pia weighing 170 gmms (5$\frac{3}{10}$ ozs.). It covered almost the entire right hemisphere. Gyri of right side were slightly flattened and of pinkish hue. Puncta vasculosa marked. The ruptured vessel not found.

The second is a case of inter-meningeal hemorrhage with general symptoms, reported by Clemen.* Female, 67 years. Intense headache, chiefly frontal ; worse from 8 to 10 P. M. At times wakeful and restless for days together, and then would become drowsy and semi-unconscious. No motor paralysis ; incontinence of urine : general hyperæsthesia ; cerebral breathing at times ; sometimes twitchings of flexors and pronators of both forearms. Old bloody intra-meningeal effusion was found between dura and arachnoid, over both hemispheres, extending into the middle posterior fossæ of the skull on the right side ; only in the middle fossa on left side the clot was thickest in convexity. Also some adhesive meningitis, supposed to have been due to slow simultaneous multiple capillary hemorrhage.

Dunn† has recorded the details of a case of clot over the motor area causing rhythmical motions of the other side of the body. The patient was a female 73 years old. Congestive apoplexy. (?) Fair recovery in a few days. Second attack during the night. Regularly recurring rhythmical movements of the left side of the body. Sensation and consciousness were normal. The right side of the body could be moved at will. Articulation impossible. Incontinence of urine and fæces. The movements of the body continued during sleep, and gradually lessened, leaving the leg on the fourth day and arm on the fifth. A clot as big as a hen's egg was present on the right side of the brain : this was superficial, reaching from the pre-central gyrus to the occipito-parietal fissure, and from the longitudinal fissure to the temporo-sphenoidal lobe.

Cortical Hemorrhage.

Sub-dural or inter-meningeal hemorrhages are frequently also cortical, that is, they invade or involve the pia-arachnoid and cortex. Occasionally, however, cases of intra-cranial hemorrhage occur which may be more particularly classed as cortical or sub-pial. These are usually limited in size, and often take place from arterioles or capillaries. A case reported by Horsely ‡ illustrates what is meant by one of the forms of true cortical hemorrhage.

This was the case of a man who had been suffering from tubercular disease of the bone for some months, and suddenly developed symptoms of thrombosis of the longitudinal sinus with cortical epilepsy as the result. The case is interesting not only as one of a peculiar form of cerebral hemorrhage, but also because of its teachings with reference to the area for the turning

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* Medical Press and Circular, 1886, vol. i., p. 335–336.

† Jour. of Am. Mod. Ass., 1886, vol. ii., p. 75–76.

‡ Brain, April, 1888.

of the head and eyes to the opposite side, and, at the same time, the anterior limit of the upper limb area, together with the special representation of the segments of that limb at the anterior part of the region devoted to it. "The movements observed were first turning of the head to the left; then raising the arm at right angles to the trunk in complete extension, with extreme extension of the wrist and interosseal position of the fingers; gradual turning of the head to the right, and subsequently the rest of the body involved in the spasm."

Thrombosis of the sinus and veins was present and caused the following lesions. "*Right hemisphere.*—The surface of the hemisphere appeared perfectly normal, except in the neighborhood of the blocked frontal vein before described. The posterior sixth of the middle frontal convolution in its whole breadth was the seat of a hemorrhagic extravasation. The ascending frontal convolution was highly congested, especially in its anterior border; the membranes also of the superior frontal sulcus were congested along its posterior third, and there was a slight hemorrhagic extravasation in the outer border of the middle third and the superior frontal convolution of this side (the right). *Left hemisphere.*—There was a dark black hemorrhagic focus occupying the anterior half of the middle third of the superior frontal convolution for half its breadth. This, the only lesion in the left hemisphere, was situated at the highest point of the area for the head and neck in the left hemisphere."

Small, superficial, cortical extravasations of this kind are to be localized by the rules and principles for irritative and destructive lesions of the brain surface of whatever character.

Intra-cerebral Hemorrhage.

Intra-cerebral hemorrhage will next engage our attention. Of course a hemorrhage may take place anywhere within the cerebrum—in the pre-frontal, postero-frontal, parietal, occipital or temporal lobe, but we cannot stop here to differentiate between the varieties of hemorrhages occurring in these positions. The remarks upon the localization of lesions of any kind in these locations will in large part apply to hemorrhage. In this connection the discussion will be largely confined to those varieties of intra-cerebral hemorrhage which are most common, and which might be said to have become almost classical—the cases of hemorrhage into or near the great ganglionic masses.

Commonly intra-cerebral hemorrhage occurs, as Gendrin and Charcot * have pointed out, not in the body of either the caudate or lenticular nucleus, but rather just in contact with the external surface of the lenticular ganglion. Not infrequently small hemorrhages occur in these positions. When a large hemorrhage occurs, it forces its way especially in a transverse direction, tearing through and pressing aside the brain substance, the greatest compression taking place towards the lateral ventricle because the resistance is least in this direction. Symptoms of both destruction and pressure abound in such cases and are sometimes hard to separate. Sometimes the hemorrhage breaks through the ganglia and the internal capsule and inundates the ventricles.

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* To Charcot we are indebted for our most exact knowledge of this branch of the subject of localization.

The central branches of the middle cerebral artery play the most important role in such hemorrhages. Charcot * has indeed proposed to call one of the branches of this middle cerebral artery "the artery of cerebral hemorrhage." This vessel after having entered the third segment of the lenticular nucleus traverses the superior portion of the interior capsule and then enters the body of the caudate ganglion. In rare cases the surgeon might trephine successfully for intra-encephalic hemorrhage. This must be done, if at all, at a point where it has been determined by pathological observation that the hemorrhage in its enlarging waves outwards usually comes nearest the surface, or would be most easily reached and relieved. The cases of hemorrhage in which the ventricles are broken into and inundated would probably be benefited only very rarely by operation, but no harm could be done in such an almost necessarily fatal case.

Intra-cerebral hemorrhage may occur in any one of half a dozen positions with reference to the three great ganglia at the base of the brain, and the internal or external capsule. With our present knowledge the exact position of some of these hemorrhages cannot from any localizing data be accurately determined. It remains true now, as stated by Charcot ten years ago, that lesions confined to any one of the gray central ganglia when the internal capsule is not involved, do not give any special diagnostic features. We have no characteristic symptoms based upon a knowledge of the functions of these ganglia. Certainly a hemorrhage or other lesion cannot yet be very positively determined as limited to either the caudate or lenticular body or the thalamus.

With reference to hemorrhage without ventricular inundation several locations in or near the ganglia may be diagnosticated. If the hemorrhage has occurred at a position corresponding to the anterior half, or perhaps two-thirds of the lenticular ganglion and internal capsule, the chief effect is the production of motor paralysis of the opposite half of the body with symptoms of the acute apoplectic attack, which symptoms are practically the same for all

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* Lectures on Localization in Diseases of the Brain. Translated by Edward P. Fowler, M.D., New York, 1878, p. 73.

the non-ventricular varieties. If the hemorrhage has occurred so as to be related to the posterior third of the capsule, where it lies chiefly between the lenticular body and the thalamus, paralysis both of motion and sensation of the opposite side of the body will be the great feature. When the extreme posterior limit of the internal capsule and ganglia are the seat of extravasation, contralateral hemianæsthesia without hemiplegia will be present; but this variety is comparatively rare. Many facts with regard to the regional diagnosis of such hemorrhages have been given by Charcot. It does not come within the purpose of my paper to discuss the exact arteries affected, and various other collateral matters anatomical and pathological, but I wish simply to give the persisting diagnosticating features of these forms of hemorrhage; and the symptoms usually observed at the time of the apoplexy. The latter are loss of consciousness, more or less complete according to the extent of the hemorrhage; stertorous respiration, sometimes so far as the mouth is concerned, one-sided; sometimes also Cheyne-Stokes; temperature at first lowered and afterwards rising; pulse sometimes slow and full, sometimes weak and intermittent. Conjugate deviation of the head and eyes may be present but is not invariable; it is usually away from the side of the paralysis. It is not infrequently somewhat difficult to determine the full extent and character of the paralysis and loss of sensation, if this also be present, in these cases of apoplexy. Careful inspection of the face, however, will usually show some drooping on the side of the paralysis and some pulling to the other side. Watching the limbs, the unparalyzed members will be seen to be used by the patient occasionally. The paralyzed extremities when taken hold of are usually limp and offer no resistance, while a certain amount of resistance is offered by the limbs of the other side even though the patient may be unconscious. My experience has shown me that cases of even somewhat extensive extravasation into the capsules and ganglia, differ considerably in the amount of paralysis produced. A fuller knowledge of intra-cerebral localization may eventually throw light upon these differences. In general terms the paralysis of the limbs is usually much more complete than in cases of cortical lesion.

The following notes of a recent case of intra-cerebral hemorrhage restricted to the internal capsule and ganglia will serve to illustrate one of the forms of hemorrhage. The patient, a man 62 years old, was admitted to the Hospital in a nearly unconscious condition. When first admitted he had some use of all his limbs; but he gradually became worse and in the course of twelve hours could not respond intelligibly to anything that was said to him, but even then he could be aroused so that he would open his eyes and look around for a few moments, and then sink again into a stupor. When able to speak his articulation was thick and indistinct. For at least twelve hours he certainly understood what was said to him. His breathing was puffing and gradually became more stertorous. It never assumed the true Cheyne-Stokes type, but showed an occasional tendency to do this. After he had become totally unconscious a few conditions were positively determined. The mouth was drawn slightly but distinctly to the left; his right arm was paretic; the right leg was helpless and spastic. The left leg also remained nearly all the time as if powerless, and it was difficult to determine any difference as to loss of power of the two extremities. He had not true conjugate deviation of the head and eyes, although his head at times showed a tendency to turn to the right. The pupils were equal and slightly dilated. Knee-jerk was present and marked on the right, diminished on the left. His head temperature, taken once at a spot corresponding to a point just below the middle of the horizontal branch of the Sylvian fissure, was 96.2° on the left, and 100.4 on the right. The patient lived six days from the time of his admission. His body temperature when first taken was 96°. It rose the second day to 101°, and from that time on until his death, ranged between 99° and 102°, being at the highest point at the time of death. He developed pneumonic symptoms three days after admission.

At the autopsy, on exposing the left lateral ventricle a nearly black, irregularly shaped spot was seen reaching across the caudate nucleus where it begins to curve around the thalamus. This appearance indicated a recent clot which had not quite broken into the ventricle, still having a thin roof formed by a layer of the caudate body. The ganglia and capsules were studied by transverse sections. The anterior limit of the extravasation was towards the median line of the brain, and was three-fourths of an inch from the head of the ganglia. Its posterior limit, a narrow wedge, was one-third of an inch in front of the posterior extremity of the thalamus. The blood was still fluid, and the parts involved by the clot were chiefly the middle portions of the lenticular body and internal capsule, and an external anterior segment of the thalamus. The pia mater of the convexity was œdematous and opaque, in spots and patches hyperæmic, and Pacchyonian granulations were exuberant. The blood vessels were highly atheromous. The kidneys showed interstitial nephritis. One lung was nearly solidified, and a patch of consolidation the size of a lemon was found in the other.

In this case the hemorrhage probably occurred slowly and most likely at the site of an old cyst. In cases of rapid hemorrhage in the same locality, all the general symptoms such as loss of consciousness, changes in respiration, temperature, etc., would be more sudden and complete. If breaking into the ventricles should occur it would become more profound and threatening.

In this case, as in others, I made some experiments to determine whether the extravasation could have been reached by trephining. A needle or trocar passed through the upper portion of the third temporal convolution, or at the line of junction of the second and third, about 3 inches back of the anterior extremity of the temporal lobe, in a direction forward and downward reached the clot at a distance of about an inch from the surface. It would be necessary if trephining was attempted to thus enter the temporal lobe, low down and well back so as to avoid the Sylvian fossa and island of Reil. In a highly vascular territory like the Sylvian fossa the cortical vessels are large and near their origin from the middle cerebral and internal carotid arteries, and if in operating this fossa was carelessly penetrated, more harm than good might be done to the patient. The peculiar position in which the ganglia and capsules are located with reference to the Sylvian fossa, the island, and the descending horn of the ventricles, would constitute one of the chief sources of difficulty in attempting to trephine for intra-cerebral hemorrhage. Still the operation is not impossible, and we will probably eventually learn exactly how far it can be resorted to with advantage, probably only in a very limited number of well chosen cases.

Intra-cerebral Hemorrhage with Inundation of the Ventricles.

What now are the symptoms of intra-encephalic hemorrhage with ventricular inundation? Whether this form of hemorrhage is or is not susceptible of improvement by operative interference, its diagnosis has considerable negative practical importance. I have, for instance, known the diagnostic question chiefly discussed in an important case to have been, whether the patient was suffering from a hemorrhage which had burst into the ventricles, or from supra-dural or subdural clot of immense size. Certainly as I have seen the cases there are striking points of resemblance between some cases of ventricular and some of meningeal hemorrhage; but the points of difference are sufficient to separate the varieties if we are sufficiently careful and minute in our study.

In the Philadelphia Medical Times, for October 23, 1880, I published a history of an interesting case of hemorrhage into the basal ganglia followed by effusion of blood into and beyond the ventricles, and I have studied and made autopsies upon other similar cases. In the case reported, the patient, a man 63 years old, while eating his dinner suddenly fell unconscious; his breathing became puffing, and marked right-sided paralysis was at once observed. The right arm and leg were powerless, and inspection showed that both the upper and lower muscles of the face were paralyzed. The right eye remained partly open and the mouth was pulled decidedly to the left. Two hours after the attack it was noted that he was profoundly unconscious; his face was pale; the right eyelids did not quite close; the pupils were sluggish but equal, the eyes were directed straight forward; conjunctival reflex was present; the mouth was drawn slightly to the left; the right nostril was more dilated than the left; no sensory responses could be obtained; the skin reflexes were marked and somewhat exaggerated on the left side of the body, the triceps reflexes were well marked but the knee-jerk was not examined. General inspection showed but little difference in paralysis between the limbs of the right and left side; but closer examination revealed a more profound paralysis of the right than of the left limbs; he occasionally moved the left arm and leg, and a tendency to contracture was present on the right side. Tremulous and spasmodic movements occurred on both sides of the body, but were a little more marked on the right than on the left. The pulse on the left side was comparatively full and strong; on the left feeble, frequent, and irregular. The temperature was taken several times in both axillæ, and varied between 99° and 101.2°, but with no uniformity as to the two sides. A marked difference between the head temperature of the two sides was noted, the right Rolandic station giving temperature of 102, the left only 99.2. The breathing passed through three periods, at first it was puffing, soon Cheyne-Stokes, and two hours before death regular but constantly feebler and shallower. When of the Cheyne-Stokes type, the period of nearly regular breathing lasted from four to five minutes, the apnœal stage only from eight to fifteen seconds. When breathing began after the apnœa it presented an ascending character, but the apnœal stage began very abruptly. He died about twelve hours after the stroke, and before death the paralysis of the limbs and face became absolutely general. The pupils became more dilated but not unequal.

Autopsy.—Resting the brain on its convex surface, large masses of dark blood could be seen occupying the central region of the base from the pons to the optic chiasm; the blood enveloped the cranial nerves in this area, and infiltrated the membranes and the spaces beneath them far out into the Sylvian fissure. Hemorrhagic foci were found here and there in the pia of the cerebellar hemispheres, the substance of which showed a few bloody points. The fourth ventricle was filled and distended with dark blood; its floor showed a very slight depression or splitting at the upper part; the aqueduct of Sylvius was very greatly dilated. The lateral ventricles which were entered from below, were filled with blood; their cornua were also enormously distended with blood. The septum lucidum, fornix, corpus callosum and commissures were broken down, and the lateral and third ventricles had become one cavity engorged with blood. The anterior extremity of the left optic thalamus and the cue-portion of the caudate nucleus were broken through. The hemorrhage had apparently taken place either from one of the lenticulo-optic or one of the posterior internal optic arteries.

Certain points of difference are to be noted between this case, and the previous one in which the hemorrhage did not reach the ventricles, as, for instance, the more sudden and profound unconsciousness, the complete unilateral paralysis which soon became general, the absence of all sensory response, the tremulous and spasmodic movements of both sides of the body, and the peculiar Cheyne-Stokes breathing.

I have examined the specimen from one case of secondary ventricular hemorrhage in which the primary extravasation took place in the centrum ovale of the parietal lobe, the blood breaking through the root of the ventricle ; but usually the secondary ventricular flooding takes place in the manner and from the direction indicated in the account of the case just given.

Of primary ventricular hemorrhage I have had no experience. "Primary ventricular hemorrhage," Gowers says, "causes symptoms which may, from the first, closely resemble those of the secondary form, but more frequently the onset resembles that of hemorrhage into the substance of the brain, in the presence at first of unilateral symptoms. Prodomata are rare, but headache is occasionally met with, very variable in seat, character, and duration. The onset may be (1) By sudden apoplexy, deepening rapidly ; death may occur in a few hours. (2) By apoplexy with hemiplegic symptoms, or with convulsions. (3) In the very rare slow hemorrhage, hemiplegia first occurs alone, loss of consciousness only supervening after a few hours. Hemiplegia occurs because the blood is effused into one lateral ventricle, and causes paralysis on the opposite side by the compression of the motor path or centres. When the effusion is rapid, and both lateral ventricles quickly become distended, the unilateral symptoms quickly give place to general relaxation of the muscles and loss of all reflex action. Rigidity is often met with, but less frequently than in the secondary form ; it is usually bilateral, sometimes one-sided, and occasionally involves only the muscles of mastication ; it is often intermittent. Convulsions are also frequent, occurring in at least a third of the cases, sometimes general, sometimes affecting only the paralyzed side, or only part of it. In cases of slow onset, speech is often lost before consciousness. The power of swallowing usually persists until the apoplexy becomes profound. The temperature resembles that of other forms of cerebral hemorrhage. The malady is usually fatal, but recovery has occurred, as is proved by old and altered clot being sometimes found in the lateral ventricles, but it is possible only when the hemorrhage is small in quantity and the symptoms are slight and equivocal." The fact that recovery has occurred in such a case is a reason for considering the practicabillty of trephining.

Tapping and draining the ventricles have been performed though rarely ; but in the future, with the comparative immunity from danger in our present methods of attacking the brain, may be resorted to much more frequently. The ventricles can be reached with precision at several points, best probably from an anatomical and surgical point of view, by way of the posterior horn, or perhaps where the lateral ventricle and the middle and posterior horns diverge. Besides blood, effusions into the ventricles may be also either serum or increased cerebro-spinal fluid, or pus from an abscess.*

Various practical questions arise in connection with the subject of trephining for intracerebral clots, particularly when deeply situated. It has been suggested that it might be impossible to remove the extravasation on account of its having formed a firm coagulum. It does not always do this. Within one week I saw two cases of intra-encephalic hemorrhage, in one of which the cavity was filled with a firm clot and in the other the blood was entirely fluid although the patient had been dead more than twenty-four hours. Why this difference should occur I do not know, but it is a fact well known to surgeons that in hæmatocele, no matter where situated, when not in contact with the air, the blood is sometimes coagulated, and sometimes is not. Even though the blood has coagulated it might in some cases be removed by carefully enlarging the opening made by the knife to reach the seat of hemorrhage with flat retractors, and then extracting the coagulum in fragments with forceps or a spoon. The bleeding in case of cerebral hemorrhage is probably stopped because of the retraction of the vessel and the forming of a small coagulum in it, but of course the danger of producing a fresh or renewing an old hemorrhage should be considered. If such operations are resorted to, care should be taken not to move the patient more than is absolutely necessary.

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* Since the meeting of the Congress Dr. W. W Keen, of Philadelphia, has proposed tapping and draining the ventricles as a definite surgical procedure, describing an operation for this purpose. He says: " As we now open the belly and drain in tubercular peritonitis with such remarkable success, I would propose that we do precisely the same for the brain. That it may be done with precision and without serious injury to the cerebral tissues the history of the present case, I think, abundantly shows; that it is even *more* urgently necessary in the brain than in the chest or belly seems clear when we consider the relative effects of pressure in the two cases. In the chest or belly the walls are more or less yielding or spongy, to a large extent. They can bear great and long continued pressure but with little damage to their ultimate integrity, or to life, if the pressure be relieved within any reasonable time.

Not so in the cranium. The walls are rigid bone, and the brain can undergo but little pressure, and for a brief time (except it be gradual, as in chronic hydrocephalus) without inviting death. The fatal issue is so uniform that *any* means that holds out a reasonable hope of relief, even though it involves great risk to life, should at least be tried; and the proposal in the present paper seems, at least, to involves but a moderate danger to life with a reasonable probability of success." (Medical News, December 1, 1888.)

Cortical Epilepsy without Gross Lesion.

In cases of cortical epilepsy when the symptoms indicate a discharging lesion of a localized cortical area, operation is justifiable whether or not the probability of a gross lesion can be made out. Hughlings Jackson in the course of a discussion of a paper on brain surgery, read by Mr. Horsely* at the meeting of the British Medical Association, at Brighton, in 1886, strongly advocated the cutting out of the part of the cortex which represented the peripheral parts first in the spasm, whenever the spasm began very locally and deliberately, and when the fits were often repeated. He advocated this, no matter in what condition the brain cortex might be found. He considered it quite certain that epileptiform seizures would be impossible in such a case if enough of the so-called motor area were removed. He believed it better to have some permanent paralysis than to be subject to fits, some becoming universal. This advice has already been acted upon by Horsley,† Keen,‡ Lloyd and Deaver,§ and Hearn and the writer. The most interesting case of the kind yet reported is that of Lloyd and Deaver. Macewen rather advises against this operation, particularly if large wedges of brain tissue are to be taken out, but I believe it to be good practice, even some permanent paresis being preferable to epileptic attacks with their destructive effects on the brain.

Accessible Areas of the Brain.

More and more has that region been narrowed which cannot be reached by the venturesome surgical explorer. The lateral aspect of the pre-frontal lobe, the entire motor area, the superior and inferior parietal lobules and the upper temporal region can, of course, be attacked with the greatest facility. In the regions difficult yet possible of access, lesions of large size and of displacing character will be more readily reached. The orbital surfaces of the pre-frontal lobe can be reached and large displacing lesions removed by trephining low down in the frontal bone. In Durante's case, the tumor removed occupied the left anterior fossa of the cranium. Almost the entire temporal lobe, with the exception of the parts bordering on the midbrain is accessible. The occipital lobes have been operated upon successfully. With care the great median fissure may be entered for lesions of the marginal convolutions and limbic lobe. The longitudinal sinus has been successfully plugged and ligated. The outskirts of the ganglia have been approached, and the ventricles have been pierced. Even a tumor situated on the intra-cranial portion of the auditory and facial nerves can probably be reached and removed. Suckling and Jordan,* Bennett May,† Horsley,‡ and Weir have looked during operation with the eyes of the flesh on the foramen magnum itself. Absolutely inviolable then are only the middle region of the base, and its bordering convolutions, the corpora quadrigemina, and pons-oblongata.

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* Brit. Med. Jour., Lond., 1886, ii., 670–675.

† Ibid., Lond., 1887, i., 863–865.

‡ Am. Jour. Med. Sci., vol. xcvi., No. 4, Oct., 1888.

§ Ibid., vol. xcvi., No. 5, Nov., 1888

In the accessible areas of the brain are (1) regions in which an absolute localization can be made by positive symptoms ; and (2) regions in which a close approximate localization can be made by positive symptoms, combined with methods of exclusion and differentiation. Under the first head, come the motor, visual, and motor speech areas and tracts ; under the second, the cerebellum, the pre-frontal, and the temporal lobes, with their more or less positively determined functions. The areas for general sensation are still doubtful, but will be considered.

Motor Localization. Researches of Ferrier and of Horsley and Schäfer.

Motor localization has become almost an exact science. Properly interpreted, the phenomena produced by irritative and destructive lesions of the cortical motor area can be relied upon to lead the neurologist to a precise topographical diagnosis, with as much certainty as the stethoscope for cardiac diseases guides the thoracic diagnostician.

The latest physiological researches bearing upon this are those of Horsley and Schäfer.§ They give a new diagrammatic representation of the subdivisions of the motor area in the monkey, both upon the lateral and median aspects of the hemisphere, to which I call attention (Fig. 1 and 2). Excitation of the external surface of the hemisphere in the hands of these experimenters yielded results which were generally similar to those described by Ferrier, which they extended and confirmed, but with some extension as to detail. Comparison of these diagrams with the earlier diagrams of Ferrier, will show the direction in which recent experimentation has added to our precision in motor localization. (Fig. 3, 4 and 5).

In glancing at these more recent results in motor localization, I cannot refrain from paying a passing tribute to the enduring value of

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[*] Lancet, October 1, 1887.

[†] Lancet, April 16, 1887, vol., i., p. 768.

[‡] Brit. M. J., 1887, vol. i., 865.

[§] Op. Cit.

the researches of Dr. Ferrier. Their accuracy and reliability are shown by the fact that the results obtained, even as to detail, have been in the main confirmed by the most careful later investigators. With reference to certain questions in dispute, as for instance, the situation of the area of representation of movement of the head and eyes in the second frontal convolution and adjoining regions the existence of distinct centres or areas for the senses of touch, pain, and temperature; and the relation of the so-called angular gyrus to vision, his positions have not been seriously disturbed; at the most, it has only been necessary to modify and enlarge his views, as, for example, to admit the part taken by the gyrus fornicatus in sensation, and of the occipital lobe in vision.

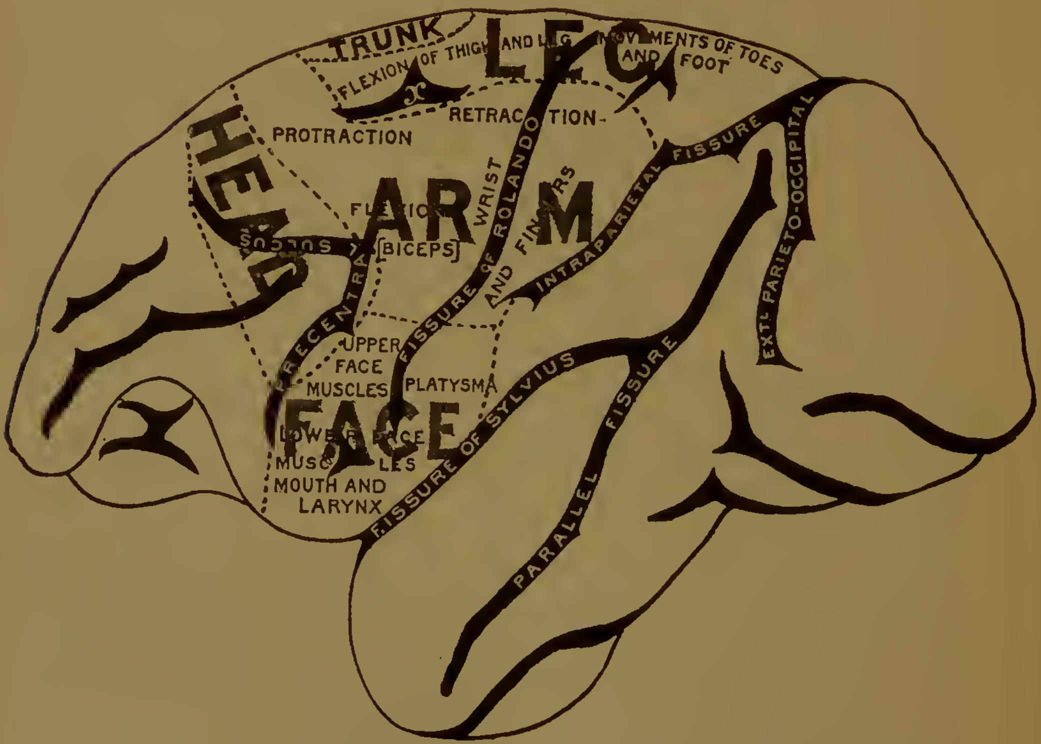

Fig. 1.—Lateral Surface of Brain of Monkey (Horsley and Schäfer).

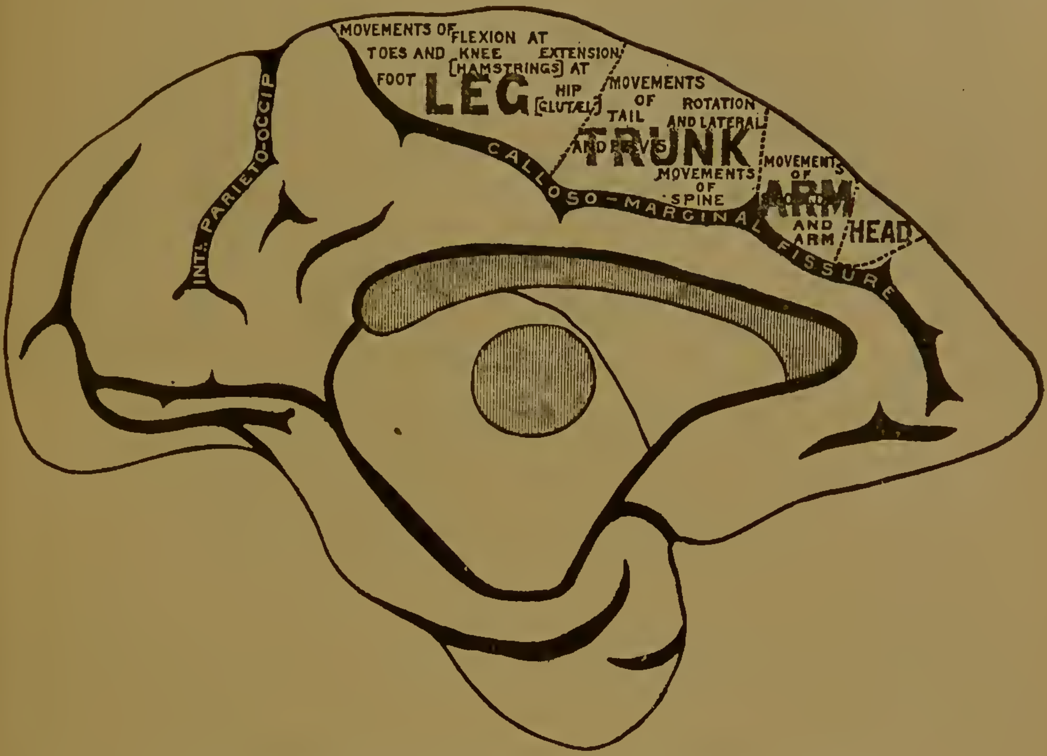

Fig. 2.—Median Surface of Brain of Monkey (Horsley and Schäfer).

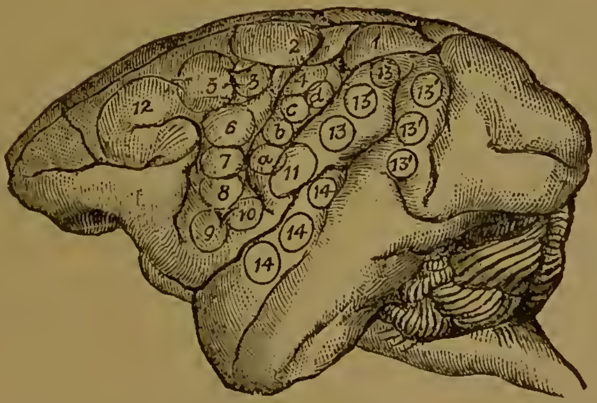

Fig. 3.—Lateral Surface of Brain of Monkey (Ferrier).

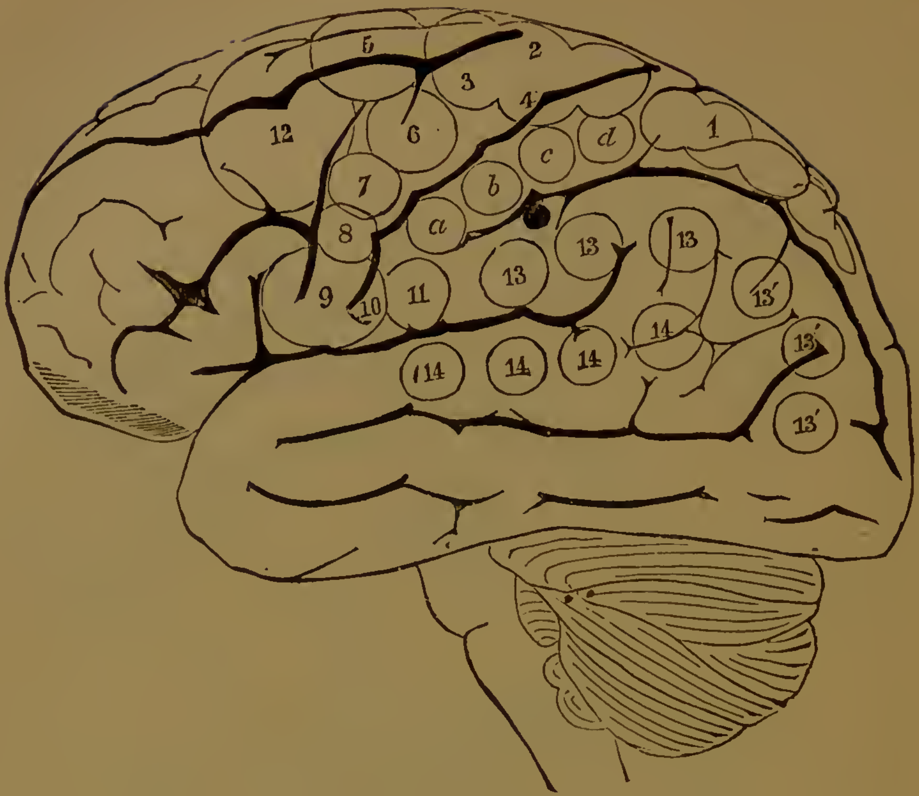

Fig. 4.—Lateral Surface of Human Brain (Ferrier).

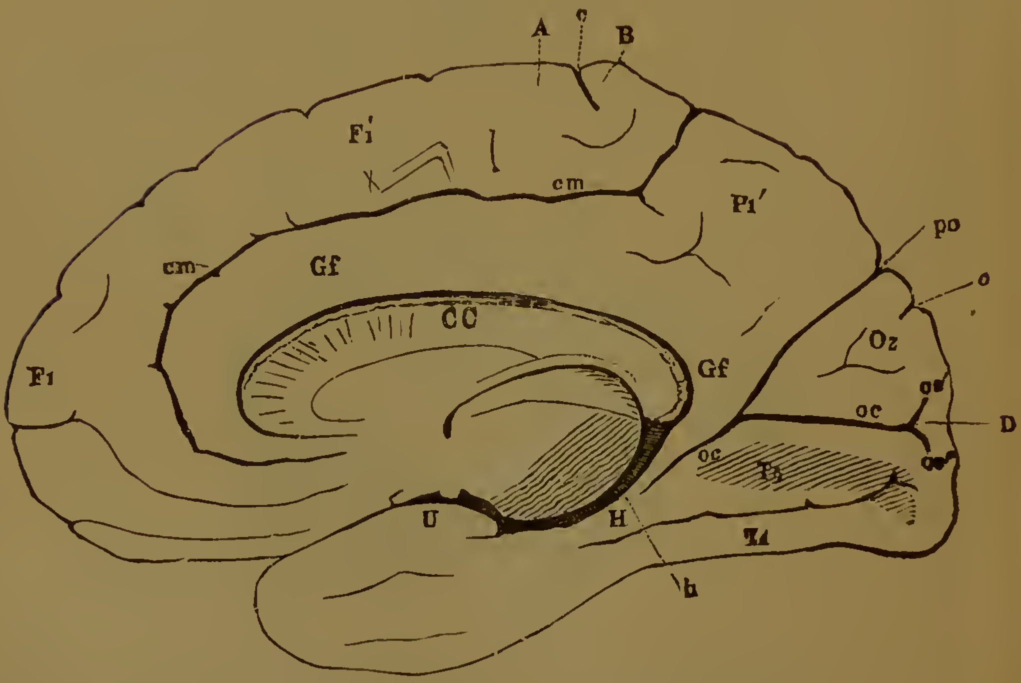

Fig. 5.—Median Surface of Human Brain (Ferrier).

On the diagrams of Horsley and Schäfer are placed the names of the zones and centres as determined by them. Below are given the explanations of the circles numbered on the diagrams of Ferrier representing both the monkey and the human brain. The numbering of the centres or areas is the same for both. The diagrams and descriptions are taken from Ferrier's treatise on the *Functions of the Brain.*

(1) placed on the posterior central and postero-parietal lobule, indicates the position of the centres for movements of the opposite leg and foot, such as are concerned in locomotion.

(2), (3), (4), placed together on the convolutions bounding the upper extremity of the fissures of Rolando, include centres for various complex movements of the legs and arms, such as are concerned in climbing, swimming, etc.

(5), situated at the posterior extremity of the superior frontal convolution, at its junction with the ascending frontal, is the centre for the extension forwards of the arm and hand, as in putting forth the hand to touch something in front.

(6), situated on the ascending frontal, just behind the upper end of the posterior extremity of the middle frontal convolution, is the centre for the movements of the hand and forearm, in which the biceps is particularly engaged, viz: supination of the hand and flexion of the forearm.

(7) and (8), centres for the elevators and depressors of the angle of the mouth respectively.

(9) and (10), included together in one, mark the centre for the movements of the lips and tongue, as in articulation. This is the region, Ferrier says, disease of which on the left side causes aphasia, and is generally known as Broca's convolution. (It will be seen later that I regard these as oro-lingual centres, but place another propositionizing speech centre in advance of this area.)

(11), the centre of the platysma, retraction of the angle of the mouth.

(12), a centre for lateral movements of the head and eyes, with elevation of the eyelids and dilatation of the pupil.

(a), (b), (c), (d), placed on the ascending parietal convolution, indicate the centres of movements of the fingers and wrists.

Circles (13) and (13), placed on the supra-marginal lobule and angular gyrus, indicate the centre of vision, which includes also the occipital lobe.

Circles (14), placed on the superior temporo-sphenoidal convolution, indicate the situation of the centre of hearing.

The centre of smell is situated in the uncus gyri hippocampi or hippocampal lobule. (Fig. 5, V.)

In close proximity, but not exactly defined as to limits, is the centre of taste.

The centre of touch is situated in the hippocampal region (Fig. 5, H) and gyrus fornicatus (Fig. 5, Gf).

Physiological Experiments on the Human Brain.

New clinico-pathological facts, obtained from surgical operations, and justifiable physiological experiments made upon the brain during such operations, have all helped to more accurately fix the sub-areas of the motor zone. In a number of operations on the motor cortex, weak faradic currents have been used to accurately localize and define the centres sought. In four instances I have seen experiments of this kind, and in one had excision of the cortex performed through the indications thus offered. I have also had the opportunity of observing the effects of faradizing the white matter beneath the excised human cortex. Brief reports of such experiments occur in accounts of operations by Horsley, Keen, Weir and Seguin, Lloyd and Deaver, and others. Horsley first resorted to this means of diagnosis nearly five years ago. The neurologists are thus to some extent repaying in kind the gifts received from physiology. Such experimentation is not only justifiable, but sometimes demanded in the interest of the patient. Gentle faradization of the human cortex does no harm, although it is not so certain that this is true of the application of the galvanic current. The light thrown upon disputed questions by close repeated examinations made after operations will be referred to later.

Boundaries of the Motor Areas.

Let us now glance at the boundaries of the various motor areas—in front, behind, above, below. The anterior branch of the Sylvian fissure, extended mentally, may be regarded as defining the anterior limit of the motor area, including the centres for emissive speech and for the head and eyes. The area which represents the movements of the face is somewhat accurately limited in front by the precentral fissure; but the movements of the upper extremity have their representation more forward of this line, as do also those of the lower extremity. In front, indeed, the region for the representation of the upper limb extends into the mid-frontal gyre for perhaps one-fourth of its antero-posterior extent; blending in the anterior portion of this forward extension with the region for the head and eyes.

The inter-parietal (intra-parietal) fissure is usually regarded as forming the posterior limit of the motor area. This large fissure runs upward and backward across the parietal lobe. It is doubtful whether in man the whole of the superior parietal lobule or convolution is concerned with motion, and hence the so-called retro-central fissure is perhaps the more probable posterior boundary of the true motor region; the postero-parietal area being concerned, in part, at least, with sensation.

This so-called retrocentral fissure (Fig. 6, Rc) is practically very constant in the human brain, and has been regarded by Wilder and others as a distinct sulcus. I have in a few instances seen it of nearly the same length and depth as the central fissure itself. It is regarded by some as a secondary upward extension of the anterior extremity of the inter-parietal fissure. It generally runs parallel with the upper two-thirds of the central fissure, very clearly bounding behind the posterior central gyre. For practical purposes of operation, at least, this retro-central fissure may be regarded as the posterior boundary of the motor area, rather than the inter-parietal fissure as commonly described. This would leave a distinct postero-parietal region on the lateral surface of the brain in *man*, of uncertain function—a region included between the retro-central fissure in front and parieto-occipital behind.

The horizontal *branch* of the Sylvian fissure forms, as is well known, the inferior boundary of the motor region.

Until quite recently the longitudinal fissure or median edge of the hemisphere was generally regarded as the superior boundary of the motor area, but the investigations of Horsley and Schäfer have shown that this area extends over the edge of the hemisphere into the so-called marginal convolutions on the mesial aspect of the hemisphere, as represented in the diagram (Fig. 2).

As these results are not generally known, it might be well to quote from these authors their general conclusions as to motor representations in the marginal gyres.

"Looking, as a whole, at the results of stimulation of the excitable portion of the marginal gyrus," they say, "it would appear that the application of the electrodes at successive points from before backwards produces (1) movements of the head; (2) of the forearm and hand; (3) of the arm at the shoulder; (4) of the upper (dorsal) part of the trunk; (5) of the lower (pelvic) part of the trunk; (6) of the leg at the hip; (7) of the lower leg at the knee; (8) of the foot and toes." These movements, they say further, in a foot note, are the primary movements, but, as will be seen from previous descriptions, they are almost invariably complicated by secondary movements, which are usually the primary movements produced by excitation of the adjacent parts. The part of the marginal convolution which is concerned with the movements of the leg and foot is that portion which is often known as the para-central lobule.

Diagrams of the Areas and Sub-Areas of the Human Brain.

Based upon the investigations of Ferrier, Horsley and Schäfer, and others, and upon a study of cases, personal and collected from the literature of the subject, the diagrams (Fig. 6 and 7) have been made to approximately represent the areas and sub-areas or centres in the motor zone. In addition, as far as possible, I have indicated areas or centres for other functions—speech, vision, hearing, etc.—so as not to necessitate the repetition of diagrams.

These diagrams (figs. 6 and 7) approximately indicate the views held by most localizationists, as the result of experiment and its confirmation or modification by clinico-pathological observation. They represent the division of the lateral and median surfaces of the cerebrum into higher psychical, motor, sensorial, visual, auditory, olfactory, and gustatory areas; also the subdivision of the motor area into sub-areas, for speech, the head and eyes, the face, arm, leg, and trunk: and the further subdivision of these sub-areas into centres for certain specialized movements of the face, arm and leg. The diagrams for the motor sub-areas are based upon the diagrams and researches of Horsley and Schäfer, but with some modifications as to extent and arrangement. Although a large portion of the paper immediately following is devoted to a consideration of the division and subdivision of the cortex into areas and centres of representation, it will probably serve a good practical purpose to give here immediately in connection with the diagrams a general description and explanation. Only certain main fissures have been indicated by lettering, so as not to confuse: *S.* fissure of Sylvius. *R*, fissure of Rolando or central fissure. *Pc.* pre-centralor vertical frontal fissure. *Rc.* retro-central fissure, sometimes regarded as a secondary branch of the inter-parietal. *F1*, first or superior frontal fissure. *F2*, second or inferior frontal fissure. *Cm*, calloso-marginal fissure. *Ip*, interparietal fissure. *Po*, parieto-occipital fissure. *T1*, first temporal or parallel fissure. *Ca*, (fig. 7) calcarine fissure.

The pre-frontal lobe, that portion of the brain anterior to the universally recognized motor region, has been designated as the higher psychical area. This term is certainly open to objection but it is difficult to substitute it by any appropriate general expression. All portions of the brain are concerned with processes of mentation, but this pre-frontal region, as Ferrier and others have shown, seems to be related to the highest mental processes, its lesions causing, when sufficiently extensive, a mental deterioration which is essentially or mainly a defect of the faculty of attention.

The motor area on the external surface of the hemisphere is made to include the posterior portions of the first, second, and third frontal, and both ascending or central convolutions, but not to reach backwards so as to take in the superior and inferior parietal convolutions. The sub-divisions of the motor zone into sub-areas and centres are indicated by the wording on the diagram, and are explained more at length in the body of the paper. Following Horsley and Schäfer's conclusion from physiological experiment the areas for the arm and for the head and eyes are made to extend forward and upward to the median edge of the hemisphere, but few if any clinico-pathological observations support this view, which is based upon physiological experiment and is probably correct. While, therefore, the portions of the first frontal convolution marked with asterisks * * may be regarded as theoretically included in the areas for the arm, and for the head and eyes, we are not justified for operative purposes in extending these areas above the first frontal fissure. No sub-divisions of the head, arm, trunk and leg areas in the marginal convolutions on the mesial surface of the hemisphere have been made in the diagrams, as these could only be so far our present knowl-

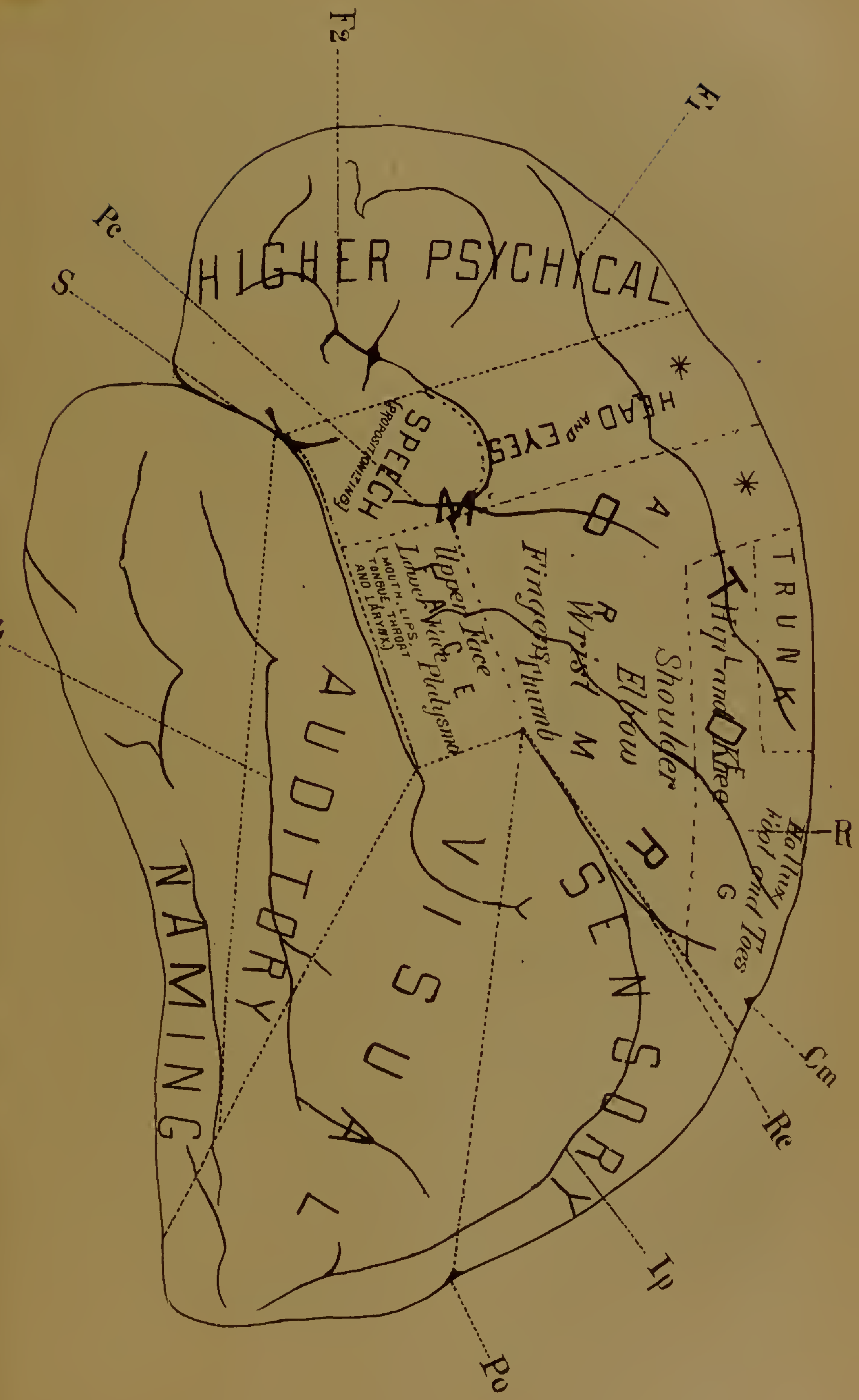

Fig. 6.—Areas of the Lateral Aspect of the Cerebrum, and Sub-divisions of the Motor Area.

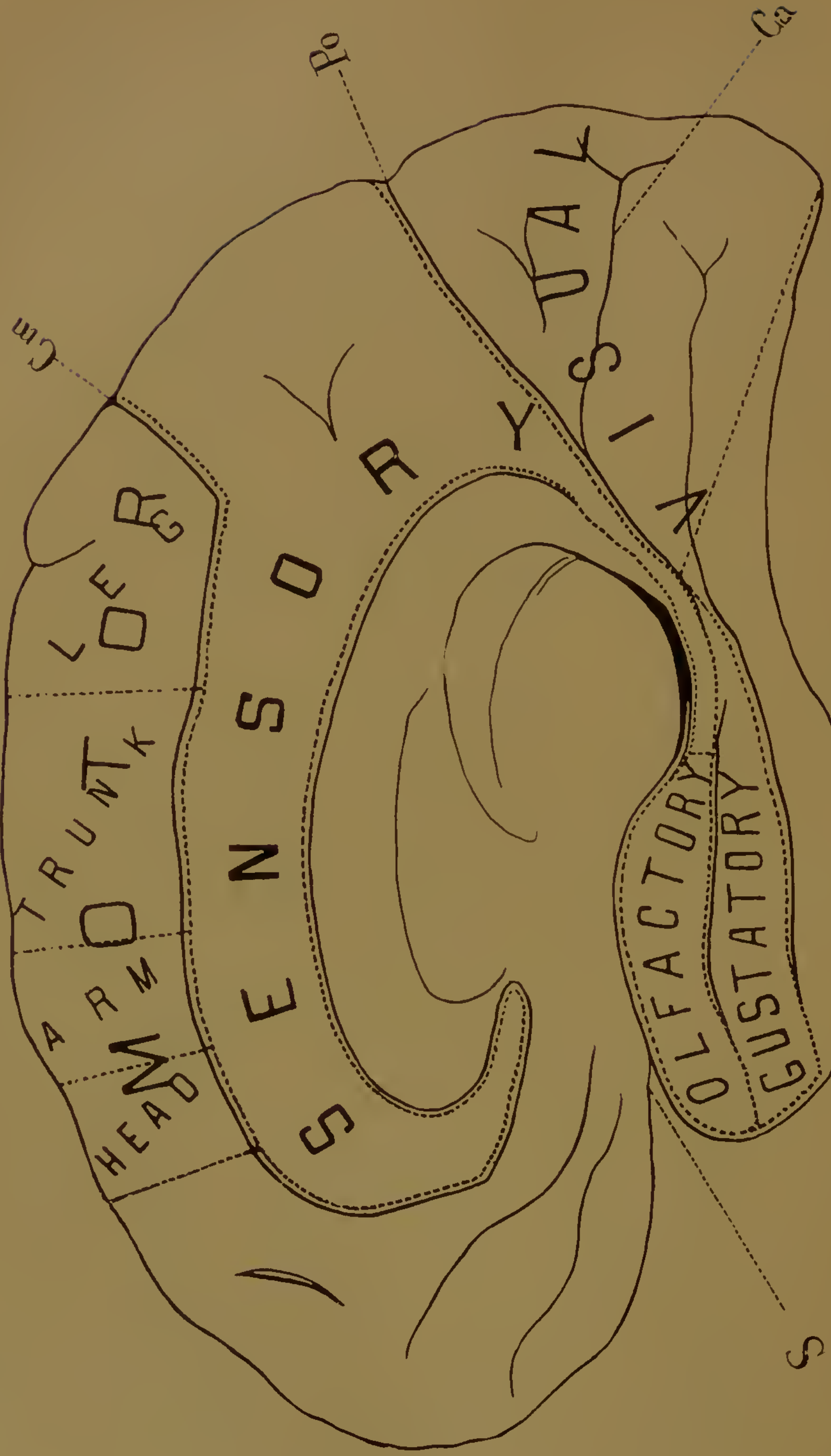

Fig. 7.—Areas of the Mesial Aspect of the Cerebrum.

edge goes, a reproduction of the subdivisions given by Horsley and Schäfer in their diagram (Fig. 2).

By the sensorial area is meant that for the senses of touch, pain and temperature, and modification of these senses, and it has been made to include the gyrus, fornicatus, hippocampal convolution, precuneus, and also portions of the superior and inferior parietal convolutions. This sensorial area has therefore been extended to the external surface of the cerebrum so as to include the general postero-parietal region. This keeps the motor and sensory areas distinct and is based upon the reports of cases with autopsies in which marked disturbances of sensation have been present, although experiments on the lower animals do not seem to have differentiated a sensory area in this lateral external region of the brain. The more elaborate development of the human brain in this region must not be lost sight of in considering this question. It is probable that the exact limitation of the area of common sensibility in the cerebrum has not yet been determined ; but anatomical and morphological observations as well as clinico-pathological facts, point to the separation of this sensoral area from the motor region by the great calloso-marginal fissure on the median surface, and on the lateral aspect by it and the so-called retro-central fissure, *Rc*, the parieto-occipital fissure sharply demarcating it behind.

The visual area is represented in the two diagrams so as to take in all of the occipital lobe and adjoining portions of both the temporal and parietal lobes including the so-called angular gyre. Such a delimitation brings into fair accord the findings in reported autopsies, and the researches of Ferrier, Munk, Schäfer and others.

Auditory localization is still in an uncertain state, but limited pathological evidence favors localizing this faculty, as Ferrier advocates, in the first temporal convolution and probably also in the adjoining second temporal.

The views of Ferrier have been accepted as to olfactory and gustatory localization, according to which the centre for smell is located in the uncinate gyrus, and the sense of taste is closely related to that of smell, and may therefore be provisionally placed in the adjoining fourth temporal convolution. Possibly it is farther back in the temporal lobe than has been indicated in the diagram.

An area including the middle region of the temporal lobe—the third temporal convolution, and adjoining portions of the second and fourth has been designated provisionally as the ideational centre or region. This is in accordance with the views of Broadbent,* Kussmaul,† and some others. I believe the ground taken by these authors is a correct one. The only question in my mind is as to the exact localization of these centres for which they claim a dwelling place somewhere on the sensory, or receptive side of the nervous system. A consideration of the differentiation and localization of an ideational or conceptional area in the cortex comes up more particularly in discussion of disturbances of speech, and will doubtless be treated of fully by Dr. Starr, whose views may differ from mine. It is necessary, however, briefly at least, to discuss the question in attempting a division of the surface of the brain into general areas, and therefore I touch upon it in this connection. This region is, according to Kussmaul, that portion of the cellular net-work of the cortex in which ideas are produced as a result of impressions of the most varied description made on the senses (object-and-word-images). According to Broadbent also, the formation of an idea of any external object is the combination of the evidence respecting it received through all the senses; and for the employment of this idea in intellectual operations, it must be associated with and symbolized by name. The structural arrangement connected with this process he supposes to consist in the convergence from all the perceptive centres of tracts to a convolutional area which may be called the Idea Centre or Naming Centre. This, he believes, is on the sensory, afferent or upward side of the nervous system; its correlative motor centre being the propositionizing centre, in which names or nouns are set in a frame-work for outward expression, and in which a proposition is realized in consciousness or mentally rehearsed. The destruction of this centre among other things would cause the loss of the memory of names or nouns. As a provisional guess, Broadbent placed this centre in an unnamed lobule situated on the under surface of the temporo-sphenoidal lobe, near its junction with the occipital lobe, as he believed, fibres from all the convolutions in which perceptive centres have been placed by Ferrier, converged to and end in the cortex of this region. It would certainly seem probable that either in this middle temporo-occipital region, or in the insular or retro-insular convolutions, this conceptional, ideational, or naming region is located. Let no one be misled by this use of the terms ideational, conceptional, etc., and charge that it is an attempt to locate the mind in a limited region of the cerebrum. It is only an effort towards a more thorough understanding of the mechanism of thought and speech. A very careful study of the entire subject of speech disturbances, including an analysis of cases already reported, will, I think, be convincing as to the necessity of a higher area for speech and thought, intermediate between the sensory or receptive centres, and the motor or emissive.

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* Brain, January 1879.

† Ziemssen's Cycl. Pract. Med., Am. ed., vol. xiv.

From a study of these diagrams it will be seen that it might be practically convenient to sub-divide the brain into five lobes, four of these, at least, according to the great general functions subserved, these lobes having in nearly all directions well defined fissural boundaries. (1) A *higher psychical or inhibitory lobe*, in front of the basal and anterior branches of the great Sylvian fissure and on the median surface in front of the anterior bend of the calloso-marginal fissure. (2) A *motor lobe*, including the posterior parts of the first, second and third frontal, both ascending or central convolutions, and the adjoining marginal gyres on the median surface. (3) A *lobe for general or common sensation*, including the gyrus fornicatus, the hippocampal convolution, the precuneus, and the postero-parietal gyres. (4) A *lobe of the special senses*, including the whole of the occipital and temporal lobes. (5) The island of Reil or insular lobe.

Differing views have been advanced as to the function of the island of Reil. With its adjoining parieto-temporal convolutions, it forms a distinct lobe, and is, as is well known, sometimes called the central lobe or, the lobe of the insula. Its importance and size are possibly often not fully considered by the physician and surgeon, owing to the fact that in the average human brain it is so thoroughly concealed by the overhanging fronto-parietal convolutions and the temporal convolutions overlapping from below. The position, relations, and considerable size of the insula can be best seen in some of the brains in which development is arrested or aberrant, as in those of the negro, some criminals, and in the idiotic. Thus studying the lobe, it can be seen to be a great intermediate or binding lobe, probably connecting the other lobes of the brain so that their associated and related functions may be properly performed, and also for the same purpose uniting the ganglia with the different lobes.

Case of Trephining for Cortical Epilepsy.

Before entering upon the discussion of the subdivisions of the cortical motor zone, I will give the details of a case in which the principles of localization were called in to determine the position of operation. One object of introducing the history of the case here is because in fixing the position for excision of the cortex the faradic current was used, and certain results were obtained which assist in indicating the exact site of certain sub-centres of the motor zone, as, for instance, those for turning the head, for extension and flexion of the fingers and hand, and for drawing upwards and outwards of the angle of the mouth.

M., 14 years old, when two years of age had a series of convulsions coming and going during twelve hours, and followed by a stupor which lasted several days. Six years later he again had a series of severe spasms, the epileptic status continuing for several hours; he had a third similar attack about one year later. Since, during the past five years, he has had fifteen to twenty spasmodic seizures, the intervals between them having grown shorter, so that recently they had only been a few weeks apart. Before the convulsions he was usually nervous and excitable, and on coming out of them nearly always complained of pain above and somewhat in front of the left ear. He had always been of an excitable temperament; and unusual excitability was noticeable during the six years between his first and second attack of spasm. He was, however, a bright boy, of good disposition, affectionate and careful of himself, and his general health, as a rule, was excellent. He was seen in consultation with Dr. Wilson Buckby. Twelve days before he went into a severe convulsion, and from that time he had not spoken, and had had violent spasms with intervals, in the course of twenty-four hours having ten or more distinct paroxysms. In the intervals between the attacks, he was sometimes stuporous and sometimes in a condition of excitement, but his mind was continually clouded so that he did not appreciate his surroundings.

In every seizure of the series of spasms the convulsive movement began the same way; the fingers of the right hand first flexed, then flexion took place at the wrist and elbow, and the parts remaining flexed, soon the whole arm, forearm and hand were drawn upward and somewhat outward. As one of his family expressed it, "his right arm was drawn until it looked like a chicken's wing." His face and head, after the movements in the upper extremity were well under way, were drawn a little to the right, his leg at about the same time, as nearly as could be determined, taking part in the spasm, semi-flexing at the knee, and the toes and foot contracting. The signal symptom was always the same, namely, a movement of flexion of the fingers; and the spasm was always first and most marked in the right upper extremity; it was commonly unilateral, but sometimes became general. Between the paroxysms his right arm was often the seat of a tremulous vibratory movement. Examination in the interval between two seizures, showed slight paresis of the lower portion of the right side of the face, and more marked paresis of the upper extremity, particularly of the forearm and hand. This was always more decided after each convulsive attack. Although right handed, he constantly used the left hand in preference to the right. Tactile sense could not be closely studied, but he undoubtedly appreciated sensations of touch, pain, temperature. Knee-jerk was somewhat exaggerated on the right side.

After several consultations it was decided to trephine, and if no gross lesion was discovered, to excise the cortex of the area or centre for the fingers and hand in the left hemisphere, because of the invariability with which the spasmodic symptoms began in the fingers and hand of the right side.

The trephining was performed July 28, 1888, by Dr. W. J. Hearn. At the operation were present, besides the writer and operator, Drs. W. Buckby, R. B. Burns, J. H. Lloyd, A. H. P. Leuf, W. M. Coplin, M. Imogene Bassette, J. C. Cooper and C. P. Noble. The head was shaved and prepared anti-septically. A sublimate solution was used and great care was taken with the instruments, sponges, etc. The line of the fissure of Rolando was determined by the methods of Hare and Thane, and a point was selected for the centre of the first trephine at what was considered to be the junction of the arm and face area, about three-quarters of an inch in front of the fissure of Rolando. A large horseshoe flap was made, its convexity backwards. Two trephine openings were made and bone cut away until finally the opening measured in its greatest diameter, which was from above downward, 2½ inches, and 1½ inches in its greatest width. The long axis of the opening was nearly in a line with the general direction of the fissure of Rolando. The region intended to be exposed was the lower two-thirds of the arm area, the upper anterior portion of the face area, the hinder upper part of the speech area, and a posterior strip of the area for movement of the head and eyes ; the convolutions uncovered were, therefore, presumably nearly the lower halves of the two centrals, the posterior extremity of the second frontal, and the posterior superior corner of the third frontal. No lesion of the bone or of the dura mater was found. On raising the flap of the dura mater, the pia arachnoid in the lower half of the opening was decidedly oedematous. No gross lesion could be found on inspection and close examination in the pia mater, cortex, or sub-cortex.

Careful examinations were made with the faradic current applied to the cortex with the view of locating the proper centres for excision. Four distinct responses in the shape of definite movements were obtained after several trials ; these were (1) in the most anterior position at which movements resulted distinct conjugate deviation of the head to the opposite side ; (2) a little below and behind this point, drawing of the mouth outwards and upwards ; (3) above this spot for movements of the angle of the mouth, about half an inch, extension of the wrist and fingers was produced ; (4) behind and above the latter point, distinct flexion of the fingers and wrist. Continuing and increasing the faradic application at this last determined point, the fingers, thumb, wrist and forearm were successively flexed, and the whole extremity assumed the " wing-like " position. The order of events, according to three persons who were present, and who had observed the patient's spasms, being exactly that which had been noticed in the beginning of his convulsive seizures.

As no gross lesion was discovered on careful examination and exploration, excision was performed of the cortex and sub-cortex so as to include the area excitation of which by faradism started the spasmodic movements of the fingers and wrist. The operation was concluded after the usual manner. The patient recovered from the operation without serious symptoms. In three days his mental condition was much improved ; the restlessness, irritability, and semi-maniacal condition which had been present before the operation passed away. His aphasia persisted. He had distinct paresis of the fingers and wrist, including the thumb, slight clawing of the fingers and bending of the wrist being present. This gradually improved.*

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* January 3, 1889, it is reported to me that this patient has had no spasms since the operation. He has regained almost entirely the use of his right hand and arm. He is still aphasic, although he has acquired the use of a few words.

Subdivisions of the Motor Area.

In the area for face, head, arm, leg and trunk, the neurologist should be able to locate for the surgeon, through a study of motor phenomena, at least seven or eight different sub-areas; and in order to do this it is imperative for him to have exact knowledge, not only of the anterior and posterior limits, but also of the horizontal subdivisions of this zone. Too much stress cannot be laid upon the proper separation of the region into horizontal levels; for, as Horsley* has well put the matter, the variation in the representation of motor function is greater in passing over the motor area from above downwards than from before backwards.

Horsley suggests the horizontal subdivision of the motor area mentally by means of certain sulci and their imaginary extensions. The imaginary extensions backwards of the superior and inferior frontal sulci through the central or Rolandic fissure subdivide with approximate accuracy the pre-central or ascending frontal gyre into three areas or zones from above downwards, namely, for the lower extremity, upper extremity, and face. According to Horsley, also, a line drawn forward from the anterior lower end of the intra-parietal sulcus will mark distinctly the division between the representation of movements of the upper limb and of the face behind the fissure of Rolando. This suggestion, however, is not as good a one practically as that with reference to the two frontal sulci. In the human brain, at least, the lower end of the intra-parietal sulcus is by no means fixed; it is often as low down as the end of the central fissure. It is better simply to place the posterior part of the area for the face in the lower third or fourth of the posterior central convolution.

The old method of subdividing the motor zone was by cutting the fissure of Rolando into thirds, and locating a circular or elliptical area over each of these thirds on both sides of the fissure—and upper area for the lower extremity, a middle one for the upper, and a lower one for the face. Such a sub-division is not now exact enough for accurate topographical diagnosis for operative purposes.

Instead of subdividing the central or Rolandic fissure into thirds, it is better perhaps to divide it into fourths, placing the area of representation for the lower extremity in the first fourth; that of the face in the lower fourth, and the areas for the upper extremity include the second and third fourths. This makes the diagrammatic method of representation correspond more closely to the results of recent investigations, as the vertical extent of the arm region on the lateral aspect of the hemisphere is about twice as great as that for the leg and somewhat greater than that for the face. The fissure of Rolando does not extend usually as far as the Sylvian fissure, and therefore making the junction of the third and last fourths of the former fissure the upper boundary of the face area, gives this area a greater height than that for the leg, but not as great as that for the arm.

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* Am. Jour. Med. Sci., April, 1887, p. 342-369.

Although time will not permit lengthy consideration, it will be interesting briefly to discuss some of the ascertained facts with reference to the sub-areas or centres in this wonderful motor region.

Subdivisions of the Face Area.

In the first place, the face area is best subdivided into an upper and a lower sub-area. In the upper sub-area movement of the opposite angle of the mouth and of the lower face generally, are represented. In three cases during operations on human beings, I have observed faradization of the anterior superior portion of this face area produce contraction of the opposite angle of the mouth and face. It is probable that in the extreme upper anterior portion of this area, immediately adjoining the area for the head and eyes, is a sub-centre for such movements of the upper face as contraction of the frontalis and orbicularis palpebrarum muscles. Such a centre does not come out clearly as the result either of physiological investigation, or the experiments of disease, because associated movements are apt to remain even after destruction of a centre for such movements on one side of the brain. Of the face area Horsley and Schäfer say that it is physiologically remarkable, that many of the movements which result from its excitation are apt to be executed bilaterally, which is only exceptionally the case with excitation of the other areas (except that of the head and eyes). Excitation of the upper third or half of the area, they continue, causes winking or closure of the eyelids, elevation of the ala of the nose, and retraction and elevation of the angle of the mouth.

An observation of Dr. Berkeley, of Baltimore, helps to fix with positiveness the exact location of the cortical centre for the movements of the angle of the mouth, chiefly performed by the zygomatic muscles, in this upper anterior portion of the general area for the face at a point about opposite the usual position of the fissure between the middle and inferior frontal convolutions. Gowers, in his Manual of Diseases of the Nervous System, page 663, has a cut from a photograph furnished by Dr. Berkeley, showing a small focus of softening in the ascending frontal convolution at this point. This very circumscribed focal lesion caused persistent clonic spasm, chiefly of the zygomatics. My observation on the case trephined by Dr. Hearn, confirms this position for the centre for this movement, as gentle faradization of the cortex at this spot caused distinct drawing of the mouth upwards and outwards. The centre for the orbicularis palpebrarum, as stated is doubtless in close proximity, probably just above the position of the centre for the angle of the mouth. While it is not usually the case, paralysis in the upper distribution of the facial nerve sometimes does take place as the result of cortical lesion. In one of my cases of tumor in the posterior portion of the second frontal convolution, and causing some destruction by the invasion of the ascending frontal, distinct lagophthalmus of the opposite side was present. No lesion of the cranial nerves at the base was present. In this case ptosis was present on the other side, that is, on the side of the lesion. The fact that in facial spasm whether secondary after a peripheral facial paralysis, or primary from nerve or central lesion—the orbicularis palpebrarum and zygomatic muscles usually act together so that the eye is closed or partly closed at the same time that the angle of the mouth is drawn upward, and the naso-labial furrough deepened, is clinical evidence in favor of the close proximity of the zygomatic and orbicularis palpebrarum centres in the cortex. Close examination of cases of hemiplegia and monoplegia will often show weakness of the movement of closure of the eyelids, in the paralyzed side, a paresis which would not be observed by a careless observer.

The lower two-thirds of the face-area may be divided into at least two parts, an anterior and a posterior. As the question of the exact function of this lower anterior portion of the face-area is one of considerable importance, and one about which some doubts still exist, I will briefly detail some of the facts with reference to this sub-centre. Beginning with the most recent contribution to the question, it may be first stated that Dr. Felix Semon, working in conjunction with Professor Horsley,* found that the lower end of the ascending frontal gyrus anteriorly is also excitable ; an effect being produced upon the glottis by its excitation, viz : to bring about phonatory closure of the vocal cords.

A fair amount of other evidence has been collected to show the existence of a cortical centre for laryngeal movements. In 1877,

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* Phil. Trans. Royal Soc., vol. clxxix., 1888.

Seguin* reported a case of left hemiparesis without loss of consciousness but with impairment of speech, and also of phonation, the patient after the attack never being able to control the pitch of the voice, apparently from a lack of proper action of the muscles of the pharynx and larynx. Autopsy showed the surface of the right third frontal convolution degenerated, being yellow, tough, and elastic. The same change to a less extent was found in the same location on the left side. From such observations a motor centre for laryngeal movements has been sought for in the posterior extremity of the *right* third frontal (homologous with the speech centre on the left side, in right-handed persons).

Krause,† in the laboratory of Professor Munk, in 1883, investigated this question experimentally. On excitation of the cortex he noticed rise of the larynx, and movement of the vocal bands to a position midway between expiration and phonation, lifting of the palate, contraction of the constrictor pharyngis, and movements at the base of the tongue. With extirpation experiments he found that eight dogs had lost the power of barking, on attempting which they uttered only a hoarse whine or made a sound.

Delavan,‡ in 1865, contributed a paper on laryngeal cortical centres, in which he records some valuable facts and refers to the observation of Seguin, Krause and others.

Garel§ read before the French Society of Otology and Laryngology, in April, 1886, an interesting communication on the laryngeal cortical centre, and vocal paralysis of cerebral origin, in which he reported a case with the details of an autopsy and a sketch of the locality of the lesion. The inferior portion of the precentral gyre on the *right* side was slightly adherent to the meninges. The membranes being stripped the surface beneath presented a light yellow discoloration. At the foot of the third frontal gyre were two points of red softening, but there was no lesion of the anterior portion of the third frontal. On section, these lesions were found to involve only the cortical substance, at the upper part only very slightly invading the white. The lesion of the precentral penetrated slightly into the white substance. It would seem from these experiments and observations that a centre for the movements of the larynx and throat is in the extreme lower anterior portion of the pre-central convolution, and that it is probably better differentiated in the right than in the left hemisphere.

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* Referred to by Delavan in Med. Rec., N. Y., Feb. 14, 1885.

† Cited by Horsley and Schäfer and Delavan.

‡ Med. Rec., N. Y., Feb. 14, 1885.

§ Annales des Maladies de l'Oreille et du Larynx. Tome xii., 1886, p. 218.

Somewhat numerous pathological observations corroborate the existence of Ferrier's oro-lingual centres also in the lower anterior portion of the face area, probably a little behind the centres for the throat and larynx. In these oro-lingual centres are located particularly the representation of the movements produced by the orbicularis oris, and of protrusion of the tongue. Recently a case of typical oro-lingual paresis with involvement of this region has been observed by me, some details of which will be given later when speaking of the alleged sensory functions of the motor cortex. Pathological observations also somewhat numerous have confirmed the position of Ferrier's centre for movements performed by the platysma myoides muscle in the face area behind the Rolandic fissure.

In the hinder lower portion of the face area is probably represented opening and shutting movements of the mouth, and retraction of the tongue.

Intra-cerebral Facial Tracts.

The existence and location of separate intra-cerebral facial tracts is a subject bearing a direct relation to that of the cortical areas and sub-areas for the face, and also a matter about which our knowledge is scanty.

Kirchoff,* in 1881, reported the case of a man aged 24, who had several attacks in which he became giddy, had convulsive tremors, lost power of speech, was unable to swallow, had profuse salivation, and drawing of his face to the left. Examination showed that he articulated with difficulty; labials and gutturals especially were troublesome; linguals he spoke with comparative ease. The lips were moved little in speaking; he could not whistle, but was able to approximate the lips. Saliva flowed from the mouth and there was excessive secretion of tears. The tongue was not protrusible more than one centimetre from the mouth, and it moved clumsily in the act of biting. At the time of examination swallowing was unimpeded, but the glottis was closed tardily. The patient often laughed without occasion. There was disease of the mitral valve. Ten days before death his face was suddenly drawn to the right, and his left arm and leg became powerless. Convulsions occurred from time to time up to his death.

The post-mortem revealed embolic softening of the posterior two-thirds of the right corpus striatum (caudate nucleus), the underlying

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* Archiv. f. Psych. Bd. XI,, and Brain, July, 1881.

internal capsule, the outer segment of the lenticular nucleus, the claustrum, external capsule and island of Reil. The focus of softening in the lenticular nucleus was distinguished from the other softened portions by being surrounded by a wall of compact sclerosed tissue. Careful microscopic examination failed to show any disease of the medulla or pons. The author atributes the glosso-labial paralysis to the lesion of the lenticular nucleus; and the hemiplegia to the quite recent lesion of the caudate nucleus, internal capsule and other parts. Cases of bilateral affection of the face, tongue, and throat, caused by unilateral lesion of the cerebrum, are rare; the author cites two, recorded by Lepine and Magnus respectively.

Ross,* also reported a case of brain disease simulating bulbar paralysis in which the lesions were cerebral, in the ganglia and alongside of them in the capsules. In 1880, I observed a third similar case at the Philadelphia Hospital.

Hobson,† in 1882, reported a case without autopsy—the main symptoms being left hemiparesis or paralysis, or paralysis of the tongue, difficulty of deglutition, speechlessness, clenching of the jaws; the patient had one inarticulate sound for everything, and a slight sound on laughing. In 1882, Ross,‡ in an interesting paper on labio-glosso-pharyngeal paralysis of cerebral origin, traversed the literature of the subject, giving also some interesting original observations.

Subdivisons of the Arm Area.

The subdivision of the area for the upper limb, according to Horsley, is for the shoulder in the upper part, the elbow next below and behind, the wrist next below and in front, the thumb lowest and behind. In the area just above the superior frontal sulcus the movements of the lower and upper limb are absolutely blended, most markedly in the hinder sixth of the superior frontal gyre. Sometimes an epileptic fit from a lesion centred here begins by complicated or generalized movements of both extremities on one side.

At various points on the posterior central convolution, Ferrier, it will be remembered, fixed centres, excitation of which caused flexion of the thumb and fingers and firm clenching of the fist, with the synergic action of the wrist and fingers, but he did not differentiate centres for different flexors and extensors. From my own observation, I believe that the centres for movements of extension of the fingers and wrist are a little anterior and below those for flexion of the same parts.

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* Diseases of the Nervous System, vol. ii.

† Brit. M. J., April 29, 1882.

‡ Brain, July, 1882.

In one of Keen's operations* the position of the hand centre was fixed by means of the faradic current. The fissure of Rolando was determined by both the methods of Hare and Thane. The trials with the faradic currents were made according to the determination of Dr. Keen, on both the post-Rolandic (post-central or ascending parietal), and pre-Rolandic (pre-central or ascending frontal) convolutions, and also the posterior extremity of the second frontal convolution. Excitation of the post-Rolandic convolution produced no effect. On touching the cortex with the electrodes at a position which apparently corresponded to the anterior portion of the pre-Rolandic convolution just back of the precentral fissure, movements of the wrist and fingers were produced. The hand moved in extension in the mid-line and to the ulnar side at different touches, the fingers being extended and separated. Above the region in which these movements were obtained, application of the current caused movement of the left elbow, both flexion and extension, and of the shoulder, which was raised and abducted. Below the region where the hand movements were excited the application of the current produced an upward movement of the whole of the left face. In the cases of Hearn and the writer, reported above, the exact movements described by Keen were produced, that is, the extension at the wrist and separation of the fingers; also, below the spot where these movements were produced, an upward and outward movement of the face, or rather angle of the mouth. In our case, however, elbow and shoulder movements were not produced except as a secondary result. We obtained, however, a primary movement of flexion of the fingers and hand to which Keen does not refer, and which presumably was not produced. This movement resulted from touching with the electrodes a spot a little above and behind the place where the movements of the extensors were caused. Continuing and increasing the strength of the faradic applications at this point, flexions took place in succession of the fingers and thumb, and at the wrist and elbow. Keen estimated the portion of the convolution as containing the hand centre as about 1¼ inches long, and he places the centre for the wrist and fingers in the pre-Rolandic gyrus, its lower limit being at three-eighths of an inch above the temporal ridge, and its upper end where it fused with that of the elbow 32 millimetres higher up. The shoulder he placed still higher, while the centre for the upper face was in the same convolution below. These results correspond closely with those of Horsley. These facts of experiments on man would seem to uphold the view that the motor zone, in man at least, is much more extensive in front of than behind the fissure of Rolando. These results of Keen were all produced by excitation of the cortex anterior to the fissure of Rolando, supposing, of course, his determination of that fissure to have been correct. As nearly as I could determine the location of my own results were the same.*

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* Trans. of Am. Surg. Association, vol. vi., 1888, and also in the Am. Jour. Med. Sci., November, 1888.

I was present at the operation in the case of Lloyd and Deaver.† By following Reid's and Horsley's lines, an area was exposed which was supposed to be on both sides of the Rolandic fissure, about the junction of the middle and lower thirds of the central convolutions. The faradic current was then used to identify locations. When the electrodes were applied to a point which was supposed to be just back of the fissure of Rolando, the movements which occurred were in order turning of the thumb on the palm, flexion of the fingers, flexion of the wrist extending to flexion of the elbow. At a point in front and below faradic stimulation caused marked contraction of the face muscles of the opposite side. "The mouth began to contract and was drawn to the left with a tremulous motion, and soon the tongue began to protrude toward the left corner of the mouth. Soon the left thumb began to be contracted and adducted into the palm; then the fingers contracted into the palm, and about the same time the face muscles began to contract more actively, while the head was drawn to the left, and the left eyelid began to work. At the same time the hand was gradually closed, and contraction of the forearm and arm began, while the latter was drawn from the side to an angle of forty-five degrees (deltoid action), and contractions of the biceps occurred. At no time in the course of these faradic applications, anywhere within the area exposed by the trephine and forceps, did any contraction of the leg muscles occur."

Subdivisions of the Leg Area and of the Trunk Area.

The movements of the lower extremity are represented in the upper portion of the motor area, and the adjoining marginal convolution; probably hip and thigh movements on the lateral and mesial aspects of of the hemisphere near the median fissure, well formed in the area, and movements of the leg and toes farther back on the lateral aspect and also in the para-central lobule, and marginal convolutions of the median surface.

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* October 4th, 1888, since the meeting of the Congress, Nancrede of Philadelphia, before excision of the cortex fixed the position of the thumb centres by means of the faradic current. The patient suffered from convulsions which began with strong flexion of the right thumb, followed by extension of the wrist and fingers, pronation of the forearm and hand, flexion at the elbow, powerful flexion and rotation of the head to the right, thrusting out of the tongue between rigid jaws, and coincident with all conjugate ocular deviation to the right. The spot at which the faradic current was applied was estimated by Nancrede, to be from below upwards in the second fourth of the ascending parietal convolution.—*Medical News*, *November* 24, 1888.

† Since reported in the Am. Jour. Med. Sci., November, 1888.

A narrow strip of the anterior portion of the leg area appears both from the results of experimentation, and of pathological and surgical observation to be a trunk-area, this being larger proportionally on the mesial than on the lateral aspect of the hemisphere, as represented in the diagrams. Horsley and Schäfer occasionally obtained movements of the trunk when the electrodes were applied to the lateral surface near the margin of the hemisphere. On the adjoining mesial surface, however, excitation produced rotation and arching of the lower spine and the pelvis, and extension of the hip, movement of the tail to the opposite side, and flexion at the knee.

Horsley* says that at the summit of the ascending frontal gyrus begins the representation of the lower limb only, the primary movement being that of the hallux. He describes a case of traumatic epilepsy the primary movement consisting of flexion of the hallux followed by the gradual flexion of the rest of the lower limb, and that followed by successive invasion of the rest of the lower body in the usual order. A dense and cystic cicatrix was found at the upper end of the ascending frontal gyrus. In another case, in which a tumor was removed, and with it the cortex in front of the upper end of the fissure of Rolando, the only permanent complete paralysis of the lower limb was that of the hallux. In one of my own cases a small gumma involved the upper fourth of the ascending frontral, and a smaller segment of the ascending parietal, crossing the upper extremity of the Rolandic fissure. This patient had severe attacks of left sided spasm beginning with twitchings in the left toe and foot ; she also had partial paralysis of the left leg and arm, most marked in the leg. The leg area, however, as shown by Horsley and Schäfer, is largely situated upon the mesial surface of the hemisphere. According to these authors, the excitation takes effect chiefly upon the ankles and digits, producing most commonly flexion of the foot with flexion of the digits. The most marked movement in front of the upper end of the Rolandic fissure is flexion of the leg at the knee, with the addition, when the electrodes are applied more anteriorly, of flexion at the hip.

Area for the Movements of the Head and Eyes.

I cannot agree with Seguin in the recent paper by Weir and Seguin† that the centre for ocular movements is quite certainly not in the second frontal gyre as claimed by Ferrier and Horsley. Much is in favor of the view that it is situated in this neighborhood.

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* Am. Jour. Med. Sci., April, 1887.

† Op. cit.

In one of the cases of Horsley, in which operation was performed at the point of the meeting of the areas for the movement of the trunk, protrusion of the upper limb, and turning the head and eyes, the aura was contraction of the abdominal muscles followed by turning of the head and eyes to the opposite side. Other cases have been reported in which turning of the head was the starting point of the spasm. In some cases, at least, when the aura or signal symptom can be most certainly shown to be the turning of the head and eyes to the side opposite to the supposed site of the lesion, the probabilities are that the focus or primary seat of the irritation is from a lesion in this oculo-motor region. The fact that cortical oculo-motor palsies are not present as a persistent condition even when we have definite lesions of the second frontal gyre is not an argument of weight against the existence here of oculo-motor centres. Such persistent oculo-motor paralysis was not present in one of the best defined cases of lesion in the second frontal gyre ever reported, a case occurring in my wards at the Philadelphia Hospital. Such symptoms do not persist because of the automatic nuclear mechanism of the cranial nerves related to these centres.

In the last edition of Ferrier's Functions of the Brain, he adheres to his views as to the position of the oculo-motor centres, and gives some new experiments bearing upon the subject. Irritation of the base of the superior and middle frontal convolutions in monkeys, gives rise to lateral movements to the opposite sides with dilatation of pupils. The expression assumed by the animal is that of attention or surprise. The same movement, however, as Ferrier himself states, also occurs along with other special reactions, on stimulation of the angular gyrus and superior temporo-sphenöidal convolution more especially. With the latter is associated pricking of the ear from stimulation of the auditory centre. Ferrier argues that although the effects are the same the causes are different. Stimulation of visual and auditory centres attract attention movements, the same as would result from stimulation of the motor centres for those movements. Destruction of the oculo-motor centres of Ferrier, according to some experiments, causes conjugate deviation towards the side of the lesion. Bilateral destruction of these centres for the first day caused inability to turn the head and eyes, but the animal recovered. Horsley and Schäfer, and Ferrier also, got no motor or sensory symptoms from lesion of the pre-frontal lobes, except in one case in which the paralysis of the lateral movements of the eyes following the lesion of the post-frontal centres having completely disappeared, the destruction also of the pre-frontal regions caused rapid oscillations of the head, apparent inability to turn the head except en masse with the trunk, and drooping of the right eyelid. These facts, according to Ferrier, show that the pre-frontal regions belong to the same centres as the post-frontal, just as the occipital lobes belongs to the visual centres.

Attempts have been made to remove the post-frontal as well as pre-frontal region. The animal could not maintain the upright position or move its head and eyes laterally. The eyes were kept shut except on cutaneous or other sensory stimulation. Some microscopical examinations of degenerations of tracts seem also to prove that the post-frontal regions contain the oculo-motor centres. Descending sclerosis from the innermost or mesial bundles of the internal capsule, does not extend below the pons, but probably into the oculo-motor nuclei.

Horsley believes that the focus of representation of the movement of the turning of the head and eyes to the opposite side is in the middle frontal gyre, but also that these movements have a much more extensive representation.

"It must be left, for the present," he says, "an open question as to how far the representation of this important and interesting conjugate movement extends *forward* in the frontal lobe. A definite answer can only be given when the homologies between the sulci and the frontal lobe in the Macaque monkey and man have been thoroughly determined. That this area of function is continued over the margin of the hemisphere into the marginal convolution, has already been shown by Professor Schäfer and myself. * * * *

"In every instance the head and neck are turned to the opposite side, and in some parts there is produced at the same time or later, conjugate deviation of the eyes."

Horsley and Schäfer in their contribution to the Philosophical Transactions, speak as follows with reference to this area: "The *head-area or area for visual direction* comprises an oblong portion of the surface of the frontal lobe, extending from the margin of the hemisphere, round which it dips for a short distance, outward and somewhat backward to the upper and anterior limit of the face-area. Posteriorly, it is bounded by the arm-area, and in front by the non-excitable portion of the lobe. It extends, therefore, in front as far as the extremity of the precentral sulcus, and it includes the middle part of the frontal lobe above the antero-posterior limb of the sulcus, the part included in the angle formed by the antero-posterior and vertical limbs of the sulcus, and perhaps a small portion of the ascending frontal gyrus, close to the vertical limb of the same fissure. The effects produced by excitation of this are similar to those described by

Ferrier as resulting from excitation of the rather more limited area marked 12 in his diagrams, viz: opening of the eyes, dilatation of the pupils, and turning of the head to the opposite side, with conjugate deviation of the eyes to that side. If the electrodes are applied near the angle of the precentral sulcus, the ears are frequently also retracted."

In the patient referred to in whose case trephining was performed a weak current applied forward of the position at which movements of the fingers and hand were produced, caused distinct deviation of the head to the opposite side. As nearly as could be determined the electrodes were applied over the extreme posterior portion of the second frontal gyre.

Conjugate deviation of the head and eyes, when a persistent or permanent symptom, is most likely to arise from lesions of the pons, cerebellum or cerebellar peduncles.

I have thus tried to indicate the recognized centres and sub-centres of the motor zone. To such great works as that of Ferrier on the *Functions of the Brain*, and to such monographs as those of Horsley and Schäfer, Horsley and Beevor, and Seguin, I must refer those especially interested in obtaining fuller details.

Overlapping Areas.

Some of these areas it will be seen apparently overlap each other, so far as their cortical representation is concerned, hence giving positions for trephining in some cases over the border of two adjoining areas. It might be said that with a large trephine it will not be necessary to separate and localize so many areas, as an opening 1½ inch or 2 inches can be made, and even this can be enlarged by the rongeur until a suspected lesion is reached, but this is a crude method in these days of precision. Even in cases of comparatively large lesion, the complete success of the operation will depend somewhat upon the first position in which the opening is made. The ideal position would of course be one that corresponded to the centre of the lesion.

Wonderful indeed is this motor zone of the cerebrum, a marvellous mosiac of centres of function, wrought from the great conceptions and priceless labors of the artists of our own guild ; a mosiac, to each block, angle and jointure of which the neurologist can point the surgeon and say, cut here or there, or touch not this or that.

Different Classes of Localizing Symptoms, their Characteristics and Comparative Value.

The neurological diagnostician must make use of his knowledge of these areas after a definite plan, if he wishes to turn it to the best account.

When localizing lesions he must go beyond even the important distinction advanced by Brown-Sequard, and very properly insisted upon and elaborated by all subsequent writers upon localization, namely, the differentiation between symptoms of irritation and those of destruction. He should appreciate the possibility of six classes of symptoms presenting themselves for his consideration, namely, those of (1) local irritation, (2) local destruction, (3) local pressure, (4) invasions by lesions growing from adjacent areas to those under determination; (5) local instability, (6) reflex action at a distance.

In this connection I will only treat broadly of a few points, as the necessity for this subdivision of symptomatology becomes apparent when considering localization in special regions. In the motor zone the symptom of irritation is especially spasm; but irritation symptoms may occur in other localities. In the visual, aural, olfactory, gustatory, or cutaneous areas they may take the form of hallucinations or other perversions of the senses. Symptoms indicating destruction are, in the motor areas, paresis or paralysis, and in other regions such manifestations as hemianopsia, word or mind blindness, word deafness, anæsthesia, analgesia, anosmia, etc. Pressure and invasion symptoms may, of course, be indicative of irritation or destruction, but are considered by the clinician in their relations to special areas under process of determination. Invasion symptoms will at first commonly be phenomena of irritation, and later both of irritation and destruction. By symptoms of instability I refer to those manifestations which occur as the result of discharging cortical areas without demonstrable gross lesions. Symptoms of reflex action will occur mostly in connection with lesions of the cranial or other nerves, and of the cerebral membranes, particularly the dura mater. They will receive particular attention when discussing some of the sources of error in motor localization.

Certain characteristics, both general and special, of cortical spasm should be well understood. These have been best studied by a few observers, such as François-Franck and Horsley. In Franck's great work the peculiarities both of cortical, sub-cortical and capsular spasm have been determined by electrical experimentation, and are carefully described and graphically represented, the phenomena having been enregistered. Horsley, practically concurring with Franck, enumerates these characteristics as the presence of a period of latency, then tonic spasm, then clonic spasm, arrest of respiration with cyanosis and salivation.

A study of the initial symptom or sign in a case of irritative cerebral lesion, and also of the serial order of phenomena, may be of the utmost importance. Seguin has proposed to call this initial symptom the "signal symptom." Horsley's view of the manner in which movements are represented in the motor cortex is that in any given part of the cortex as minute as can be examined experimentally, there is represented a definite movement or combination of movements, being the primary movement and elicited by minimal stimulation only ; and that secondary movements are due to the subsequent invasion by the discharge of nerve energy of portions of the cortex which lie nearest to and are in close relation with the parts stimulated. The primary movement gives the signal symptom of Seguin, and the secondary movements represent the "serial order" of phenomena.

The signal symptom in Jacksonian spasm has already been made use of in a number of cases to guide the surgeon in part or whole in selecting the site for operation.

In one of Horsley's cases there was first tonic extension and clonic spasm of the right lower limb. "The right upper limb was then slowly extended at right angles to the body, the wrist and fingers being flexed ; the fingers next became extended, and the clonic spasms of flexion and extension affected the whole limb, the elbow being gradually flexed. At this time, spasms in the lower limbs having ceased, those in the upper limb continued vigorously. The spasm gradually affected the right angle of the mouth, spreading over the right side of the face, and followed by turning of the head and eyes to the right."

In another case first came "clonic spasmodic opposition of the left thumb and forefinger. The wrist next, and then the elbow and shoulder were flexed clonically, then the face twitched and the patient lost consciousness. The hands and eyes then turned to the left, and the left lower limb was drawn up. The right lower limb was now attacked, and finally the right upper limbs. Paralysis of the left upper limb frequently followed a fit. At frequent intervals every day the patient's thumb would commence twitching, but the progress of the convulsion could often be arrested by stretching the thumb and applying a ligature."

In another case by the same surgeon the spasm was ushered in with a desire to defecate, sometimes with sharp pain in the left side of the belly. Then followed tightness of the throat, and sometimes spasmodic cough. Then the head and often the eyes turned to the right; the right arm was jerkily protruded, and the patient became unconscious. All the limbs became powerfully flexed, as a rule, but the lower limbs were frequently extended.

Weir and Seguin, Keen, Lloyd and Deaver, the writer, and others have taken advantage of the signal or initial symptom in fixing a site for operations, and thus, either with or without gross lesion, hand centres, thumb centres, face centres, etc., have been excised.

Even movements of the trunk have been used to guide operation by Horsley.* "As regards the trunk muscles," he says, "much might be said, but reference for detail is invited to the above mentioned paper in the Proc. Roy. Soc., 1885. It is, however, worth while pointing out, psychologically speaking, that there is scarcely ever performed a highly purposive act by the trunk muscles only. The movements of the trunk are simply subordinate to the purposive movements of the limbs, and consequently we should not be surprised to find, as in this case, how extremely small a portion of the cortex is sufficient for primary representation of this part of the body. An illustrative case of the position in the human brain of the areas we have just been considering, is that of a case in which a man had been a victim of traumatic epilepsy for many years due to a small punctured fracture of the skull, the said fracture being demonstrated externally by a minute depression three or four millimetres broad. The puncture had caused splitting of the inner table, laceration of the dura mater, and partial destruction of the subjacent cortex, so that at the time of operation (eleven years later) there was found a rough ring of bone on the inner surface of the skull around the centre of the fracture, from which a sharp and corrugated fragment, one cm. long by five mm., broad projected downward, together with a flap of entangled and torn dura mater, into the wall of a small cystic cavity in the cortex just above the junction of the middle and posterior thirds of the superior frontal sulcus. This fairly extensive lesion, which was freely removed (the result being cure of the epilepsy), was thus situated at the point of meeting of the area for raising with protrusion of the upper limb, and of that for turning the head and eyes to the opposite side of the body. The existence of such a lesion was diagnosticated from the fact that the course of events in the epileptic fit began with an aura of contraction of the abdominal muscles, this was followed by turning of the head and eyes to the opposite side, and then there occurred the raising of the upper limb. The exemplifications of the topographical relations of these centres was thus faithfully demonstrated."

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* Am. J. Med. Sc., vol. xciii., n. s. 1887, p. 367.

Sub-cortical Lesions and the Intra-cerebral Tracts.

It will be well to say a word or two here about the diagnosis of sub-cortical motor lesions—tumor, cyst, hemorrhage or abscess—which has practical importance, not only for its own sake but chiefly because, in some instances, the question of proceeding with an operation might depend largely upon the supposition of a lesion being sub-cortical. In the case of Weir and Seguin, after the flap of the dura mater was reflected and the brain exposed, nothing abnormal was seen on the exposed surface, and the finger at first recognized no tumor nor abnormality; but at the depth of nearly an inch a small growth was found. If the probability of the presence of a sub-cortical lesion had not been fully considered in this case the operation might have been absolutely fruitless. After a somewhat elaborate study of the question of the diagnosis of sub-cortical tumor, Seguin concludes that in favor of a strictly cortical or epi-cortical lesion are these symptoms, none of them having specific or independent value: "Localized clonic spasm, epileptic attacks beginning by local spasm, followed by paralysis; early appearance of local cranial pain and tenderness; increased local cranial temperature. In favor of sub-cortical location of tumor: local or hemiparesis, followed by spasm; predominance of tonic spasm; absence, small degree, or very late appearance of local headache, and of tenderness to percussion; normal cranial temperature."

The neurologist will probably in time be able in some cases to diagnosticate with sufficient accuracy for surgical purposes, lesions so situated as to destroy intracerebral traits in various regions of the brain. Studies of the different forms of aphasia demonstrate the truth of this proposition. As the various sensory and receptive centres concerned in the production of speech are situated in the parieto-temporal and temporal regions of the brain, the tracts connecting these areas with the motor or emissive speech regions, both for proposition and utterance, must lie in a space of a few inches from before backwards and from above downwards in the region bordering or lying within the Sylvian fissure.

Starr* has brought together in compact form some of the most important facts bearing upon the physiology of the intra-cerebral tracts, drawing largely upon Nothnagel, Charcot, Strumpfell, Flechsig, Edinger, Exner and Spitzka. At least three sets of fibres are to be distinguished in the centrum ovale, namely, the projection, commisural, and association systems. The projection system joins the cortex with parts of the nervous system below ; the commisural system corresponding areas of the two hemispheres ; the association system different convolutions of the same hemisphere. The investigation of these different systems is an intricate study, still involved in much obscurity ; but it does not come within my province to consider it in this paper except in the most practical way, in connection with the localization of gross lesions.

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* Med. Record, Feb. 13, 1886.

A careful, elaborate, clinical study of hemiplegias, monoplegias and aphasias, will eventually enable us to separate with considerable certainty lesions of the cortex from those of the centrum ovale, capsules, and ganglia. We will do this by relating the symptoms found not only to lesions of the cortex and the projection system of fibres, as is too commonly the restriction placed on our studies in this direction, but also, to lesions of commisural and association fibres. I am convinced that a lack of consideration of these commisural and association fibres is at the bottom of much of our confusion in analyzing certain cases. Very few lesions are absolutely cortical. Many of those which are generally regarded as cortical, involve to a greater or less extent the sub-cortex. As every convolution of the cerebral surface is connected with some other, and probably with many other convolutions, some association fibres must nearly always be destroyed in these cases.

Differential Diagnosis, particularly of Jacksonian Epilepsy—Dural and other Reflex Epilepsies.

Sufficient diagnostic difficulties are still present to make it important in the light of the tremendous impetus towards operations to carefully examine all questions of differential diagnosis. We should know, in connection with cerebral motor localization, whether certain affections do not simulate cortical epilepsy so closely as to sometimes endanger exact diagnosis. In certain motor and especially spasmodic affections, for example, we have striking resemblance between affections clearly of reflex origin and those as demonstrably central. Trigeminal epilepsies, whether dural, facial, dental, nasal, pharyngeal, laryngeal, or of whatever local origin, may cause unilateral convulsions or even monospasm. Brown-Sequard has contributed largely to our knowledge of this subject both in his early and recent researches. During a few years stimulated by practical specialism, much work in the direction of diagnosis and treatment of reflex epilepsy has been done, some of the best of it by members of the Associations represented in this Congress. The same conclusion might be arrived at for all, as that of

Boucheron[*] with reference to aural epilepsy, namely, that spasm may proceed from lesions of the ear, eye, nose, pharynx, larynx, face, scalp, or dura mater, and may present all the clinical varieties of epilepsy, or even a form of hystero-epilepsy; and that the point of origin of these disorders is intense excitation of a sensory nerve.

Dural epilepsies are especially worthy of attention. During a recent operation in one of the Philadelphia hospitals a faradic current accidentally applied to the dura mater, almost instantly produced spasm which invaded the whole body. Dupuy[†] has published various papers regarding irritation of the dura mater causing muscular movements, claiming that his results are constant when the animal experimented upon is not in a state of anæsthesia incompatible with the manifestations of animal life, and when it has not lost too much blood. Brown-Sequard and Burdon Sanderson have recorded similar phenomena; and the facts of these experiments have been used as arguments against cortical localizations. The Committee of the New York Society of Neurology and Electrology, in 1874, found that galvanization of the dura or other sensitive parts produced by reflex action, muscular twitchings, oftenest on the same side of the body. Duret[‡] has given particular attention to the rôle played by the dura mater in the production of sensory, spasmodic, and other phenomena. He does not, however, with Dupuy, hold that the fact of the production of spasms in this way in the least invalidates the doctrine of cortical motor localization, but that a clear differentiation between dural and cortical spasm can be made. Bochefontaine has shown that irritation of the dura mater determined cries of pain, and general movements more or less energetic; and also that mechanical irritation of the sensitive points of the membrane produced, in certain conditions, movements limited to one or several parts of the body, the movements of the limbs on the same side being more energetic than those on the opposite side. Franck has made careful comparison and contrast of cortical epilepsies and those which are reflex and toxic, including those which are due to irritative lesions of the dura mater. In one of his experiments[§] he produced an epileptic seizure from mechanical irritation of the dura, and among other things noted was that at the moment of the irritation of the dura mater the muscles of the face of the same side were attacked with violent convulsions. Attacks followed, as many as nine in twenty-five minutes, all clonic and generalized.

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[*] Compt. rend. Acad. de Sc. Paris, 1887, cv., 944–947.

[†] Examen de quelque points de la physiologie du cerveau. (Thèse inaugurale, Paris, 1873). Also: Experiences sur les functions motrices du cerveau, 1888. Compt. rend. des séances de l'Acad. des Sci.

[‡] Sur les Traumatismes Cérébraux, and Brain. April, 1878.

[§] Op. cit., p. 470.

The following is an abstract of the record of this experiment:

"Experiment No. 45 (Jan. 7, 1879) with M. Senna of Coimbæ. Reflex attack of epilepsy (excitation of the dura mater) commencing on the side irritated.—State of disease.—Arrest of the salivary flow in the attacks.—New series of reflex attacks by incision in the skin.—Circulatory modifications in this form of epilepsy.

"A young dog, spaniel of large size, very vigorous. The motor zone was exposed at the right side while under the influence of a slight anesthetic of chloroform; a large opening was made in the frontal sinus in order to discover the excitable region, the crucial edge forward.

"It was proposed to study at the same time with salivation, the modifications of the heart and of compression, in their connection with the cortical origin of convulsions; but the animal was taken with a reflex attack of epilepsy under the following conditions: The dura mater had been cut all round the trephining point; a fragment remained adherent to the anterior inferior angle of the wound and caused a slight flow of blood somewhat interfering with the experiments at excitation. At the time when an attempt was made to stop the flow of blood with a piece of medicated cotton, the simple friction of the strip of dura mater provoked a series of violent convulsive attacks, having their point of commencement in the muscles of the face and neck on the *same side* (contrary to the epileptic attacks of cortical origin which *always* commence in the opposite side of the body, and severely in the corresponding muscles to the cortical centre excited.)

"The first attack was exclusively clonic, very violent and generalized.

"During several minutes spontaneous attacks succeeded, separated from one another by a few seconds only; at the fourth attack the convulsive movements and the salivary escape were simultaneous. It was remarked in the first periods of the attack the salivation came on slowly; it appeared in this fourth attack only thirty-two seconds after the commencement of the clonic movements.

"The animal had nine grand attacks in succession in twenty-five minutes. Then exhaustion came on and it was quiet, the respiration rapid, the heart beats quick, and the arterial pressure much diminished.

"It was left to repose for half an hour, then wishing to apply a manometer to the femoral artery, an incision was made in the skin of the thigh. At this moment a new convulsive explosion came on and without pauses, in the same register as had been made in the former attacks." * * * * *

The nerves of the dura mater spring from the fifth pair, and are distributed nearer to the internal than to the external surface of the membrane, which explains why some lesions of the dura are more likely than others to lead to spasm. The difference depends, in part, at least, on the site and intensity of the lesion with reference to the internal and external aspects of the membrane. Sub-dural hemorrhage is more likely to give rise to reflex spasms than extravasation between the membranes and the skull, unless the blood tears through the membrane. A spicule of bone, in like manner, driven into the dura is more likely to cause reflex dural spasms than a depressed fragment; while a tumor arising in the membrane is more likely to bring about the same result than an exostosis, or a neoplasm growing from the agglutinated membranes into the brain substance, as is so often seen in intra-cranial growths.

I have notes of five cases in which operations have been performed for epilepsies apparently reflex in character. In two of these spicules of bone were removed from the dura mater. These cases bear out to some extent the views of the existence of distinctive characteristics for reflex epilepsies, but also point to certain resemblances to cases of cortical epilepsy. In one case in which fracture was present in the left frontal region, anterior to the motor area, the patient had convulsions at irregular intervals of weeks or months; usually having sharp pain at the seat of the scar before the seizure. He had no loss of sensation nor paralysis. His convulsions were frequently unilateral; I saw him in one which was confined entirely to the left side, and began in the left leg. This case was trephined for me by Dr. W. J. Hearn, of Philadelphia, and a spicule of bone dissected from the dura mater. In another case the patient was trephined by Dr. J. W. White at my request, for a fracture from a pistol-shot wound just above the right temple. Nearly three months after the injury he began to have spasms; and had had about seven seizures in all. In a convulsion which I witnessed he was completely unconscious; his body was twisted somewhat to the right; his face and all his limbs as well as his head and trunk taking part in the spasm which was tetanic in character. In another case in which an operation was performed for me by Dr. Hearn, the spasm seemed to show a somewhat confusing admixture of what might be termed dural and cortical characteristics. Notes on this case were furnished to Dr. J. B. Roberts, and were published by him in his pamphlet on the Operative Surgery of the Human Brain. In a fourth case seen with Dr. L. W. Steinbach, the patient had been subject to convulsions which seemed to date back to an injury to the head; he had a scar and apparently a depression of the skull over the frontal region. Pressure on this scar brought on a unilateral, largely tetanic convulsion on the same side as the scar. A flap including the scar was lifted, and trephining was performed, but nothing abnormal was found in the inner table or in the dura. The scar was excised. In a fifth case, the patient had convulsions, sometimes on one side, sometimes on both, and these could be brought on by pressure on a scar left by an old sabre cut. The cicatrix was cut out and the patient recovered, at least, he remained for several months in the Hospital without attacks, although before the operation he had been having them at frequent intervals.

With Franck I fear we are not always able to make a trenchant separation between cortical and reflex epilepsies; but a few points may be indicated. In reflex epilepsy the attack does not begin with brusque tetanization as in the case of cortical disease. If the reflex epilepsy has a tonic period it rises slowly to its maximum. In cortical epilepsy the convulsion begins without exception on the side of the body opposite to the side of the brain excited or irritated; in reflex epilepsy, or at least in dural and perhaps other forms of trigeminal spasm, it frequently begins on the same side as the focus of irritation. Unfortunately we have not here a radical difference as it may begin on either side in reflex cases. In the reflex cases if the spasm begins locally or unilaterally, there is not likely to be a definite initial or signal symptom and serial order of movement; one half of the body usually plunges immediately into spasm.

True Jacksonian epilepsies are, I believe, sometimes reflex in origin; that is, they become established as the result of intense persistent peripheral irritation, dural, dental, palmar, etc.; and even after the source of irritation is removed the cortical discharges continue. Herein perhaps lies the explanation of Jacksonian spasm in which gross lesion is not discovered, and herein also sometimes is to be found justification for operation for the removal of cortical discharging areas, even when such lesion is not present. Such a method of origination of cortical epilepsy is in accordance with physiological principles. Meynert,* in the development of his idea of a projection system, has perhaps more clearly than anyone else made apparent the method in which this result may be brought about. Movements which were originally reflex in character may after a time result from cortical impulses. In the normal brain no reflex actions can be performed without exciting to action secondary volitional movements which no longer requires the stimulating influence of a reflex action. Some of the observations and experiments in hypnotism, as those of Heidenhain† in particular, also throw some light upon the manner in which reflex epilepsies may develop into true organic cortical disease. The phenomena of unilateral hypnosis are particularly interesting in this connection. When certain definite cutaneous surfaces are irritated, certain muscles and groups of muscles related to these areas can be brought into isolated or successive action; stroking the ball of the thumb, for example, causes adduction of the thumb towards the palm; or stimulating the skin over the sterno-mastoid causes the head to assume the wry-neck position.

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* Psychiatry, a Clinical Treatise on Diseases of the Fore-Brain. Translated by B. Sachs, M.D.

† Hypnotism or Animal Magnetism. Translated by L. C. Wooldridge, M.D.

A case reported by me in 1880,[*] is interesting in connection with this question. It was one of epilepsy clearly Jacksonian in type, and as clearly due to a fibroma involving a nerve trunk on the palmar surface of the hand. The patient, 15 years old, had had the seizures since the age of 4 years, they coming on after an injury to the hand at the situation of the fibroma. After removal of the growth, she had spasmodic attacks of the same type as before the operation, but less in frequency for a year, after which she rapidly improved, and I have been recently informed has had no spasms for nearly two years.

A description of the usual character of the attacks shows that they were distinctly Jacksonian. The description will be quoted at length because of the importance of the matter under discussion.

> The distal phalanx of the ring finger of the right hand was first flexed; secondly, a few spasmodic movements of flexion would occur in this finger; thirdly, the other fingers and thumb of this hand would begin to twitch convulsively—the second phalanges would be flexed, the last extended; fourthly, the clonic convulsive movement would extend to the right hand, forearm and arm, and simultaneously the muscles of the lower part of the right side of the face would become affected with spasm, a tremor also appearing in the tongue during this period; fifthly, the right arm and leg would now become affected with a clonic spasm, causing them to assume positions of flexion, the head, neck and body being drawn by the spasm at the same time to the right, a condition of pleurosthotonus being, in fact, produced. The seizures would pass off with a very severe jerking movement of the right shoulder, and a renewal of the twitchings of the muscles of the right angle of the mouth. These movements of the shoulder and mouth would sometimes occur only once, just before the close of the attack; more frequently, however, they would take place two or three times in succession. Occasionally the patient would bite her tongue during the paroxysms. She apparently was never entirely unconscious during the attack, no matter how severe it might be. During the height of the convulsion, if her hand was pressed too hard she would manage to gasp out, "Don't," or to make some other exclamation.

Unilateral Nervous Affections in Bright's Disease.

Considerable evidence has accumulated to show that affections of the nervous system, strictly limited to one-half of the body, occur during the course of some forms of Bright's disease. In this country Dercum[†] has reported cases of hemichorea, hemiplegia and unilateral convulsions. Raymond,[‡] Chantmesse and Tenneson[§] reported series of cases of unilateral affections, chiefly hemiplegia and epilepsy apparently of uræmic, or at least renal origin. In not one, according to the reporters, could the trace of a strictly focal lesion be discovered. Chaufford * reports a highly interesting case under the title of uræmic convulsions of the Jacksonian form.

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[*] Phila. Med. Times, December 18, 1880.

[†] Jour. Nervous and M. D., vol. xiv., No. 8, August, 1887, p. 473.

[‡] Thèse pour le Doctorat en Médecine, 1878, Versailles, and Rev. de Méd., Sept. 1885.

[§] Rev. de Méd., Nov. 1885.

Hystero-Epilepsy and Jacksonian Epilepsy.

Some cases which seem to be clearly forms of hystero-epilepsy closely resemble organic epilepsy of the Jacksonian type. Hystero-epileptic attacks, it is well known, can be produced by irritation of the hystero-epileptogenic zones, described by Charcot, Richer, and others, which are evidently analogous to the epileptogenic zones of Brown-Sequard.† Almost every form of spasm in localization and extent can be found in the descriptions of hystero-epilepsy. Features of distinction are, however, present. Undoubtedly one reason for the similarity between spasmodic affections reflex, hysterical, toxic and cerebral, lies in the fact that in these cases, whatever may be the starting point, central areas are discharged and give definite character to the convulsions. Horsley speaks of hystero-epilepsy as a cortical disease, but this view cannot be upheld for all cases, if he means by this that the spasms are usually the result of cortical discharge. They are rather sometimes bulbar or spinal, cortical inhibition being removed.

The difficulties of making a diagnosis between grave hysteria or hystero-epilepsy, and cerebral tumor or other organic lesion with apparent or real Jacksonian symptoms, is sometimes great, and was strikingly shown in a case seen by me in consultation with Dr. J. M. Barton, of Philadelphia. This patient, a married woman, 35 years old, came under observation in the spring of 1886. She had been in bed eight weeks, and had taken no part in her household affairs for several months. Her sickness began with complaints of headaches and feelings of slight numbness in the left hand and arm ; she would occasionally drop things from this hand. She soon developed analgesia and anæsthesia in the left arm and leg, and sometimes in the face ; this varied in severity. Her mental condition gradually changed, she became irritable, absent minded, and lacking in attention and judgment. She had at times hallucinations of sight, which usually occurred after lying down, these often taking the form of animals, as cats, mice, etc., disappearing around corners. Hearing was good in the left ear, but in the right was diminished ; careful examination showed no external or middle ear disease.

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* Arch. Gen. de Méd., Paris, 1887, ii., 5–19.

† Lancet, Lond., 1886, ii., 1211–1213, Abstract of Brown Lectures.

She suffered almost continuously from headache, which she described as violent and agonizing, and which she localized mostly in the fronto-parietal region ; and a cranial area over the right motor zone was very tender to pressure and percussion. Nausea and severe vomiting came on late, and both headache and vomiting were accompanied by vertiginous sensations. A curious symptom was a constant diarrhœa, the patient having six to fifteen passages a day, and sometimes as many as twenty-four. She also often spat a bloody fluid from the mouth. Her appetite and sleep were much impaired, and she lost considerably in weight.

Ophthalmoscopic examinations made in March, 1886, by Dr. W. W. McClure, gave the following results : *Right eye* :—The pupil more active than the left ; media clear ; slight physiological cupping and venous pulsation ; no arterial movement observable. Slight choroidal change in pigmentation to the temporal side of the nerve ; outline of nerve above not defined, but merged with the retina. Macula good. Hypermetropia. *Left eye* :—Pupil more dilated and less active than in the right eye. Appearances much like those seen in the other eye, but worse. Evidences in color and margin of slow chronic inflammation. Macula good. Right eye, vision, $\frac{20}{50}$; left eye, vision, $\frac{20}{70}$.

After her illness had continued several months, the patient began to experience at times attacks of flexure of the fingers and thumb of the left hand, and cramp-like feelings in the forearm and arm. Later these spastic attacks began in the left foot, causing the great toe to be flexed upward and the other toes downward, with also some cramp feelings in the left leg.

A number of consultations were held with reference to this patient with Drs. J. B. Roberts and C. B. Nancrede, who took the view that the case was probably hysterical, and treatment was eventually suspended.

The patient's general health improved ; she gained in weight and attended to household and business affairs, never, however, getting entirely rid of her main symptoms, and recently some of these have returned with renewed vigor. She has fallen several times in public places and at her own home, appearing to become entirely unconscious. The attacks are preceded by a thrill passing up the left leg, and twitching of the left arm ; the latter continuing through the entire seizure and being the only muscular movement noticed.

Visual Localization.

Next to determinations of the motor zone visual localizations are the most conclusive, and this in spite of the hard-fought battles of the physiologists over the cortical sight areas. Clinical medicine and pathology have here come bravely forward to clear away the storm. A few well reported cases of hemianopsia with autopsies, as those by Jastrowitz,* Haab,† Huguenin,‡ Monakow,§ Seguin,‖ Hun,¶ Fere, Keen and Thomson, seem to settle beyond doubt the connection of the cuneus and adjacent region with the retina and simple visual sensation.

Jastrowitz has recorded a case of paresis of the right leg, arm, and face, with a peculiar form of aphasia. The patient was unable to read and write connectedly; he could not understand written words. The history does not relate definitely whether or not he understood spoken words. Right hemianopsia was also present. The autopsy showed tumor of the left occipital lobe and precuneus.

Seguin, in a contribution to the pathology of hemianopsia of central origin, in many respects the most valuable publication on the subject which has yet appeared, collected forty cases with autopsies, and five traumatic cases without autopsies. Eleven of these were cases of hemianopsia due to lesions of the white substance of the occipital lobe. Sixteen were cases of cortical lesion, or of lesion limited to the cortex and the white substance immediately subjacent; and four of the sixteen (those of Haab, Huguenin, Fere, and Seguin referred to above) are what might be termed conclusive cases as to the question of the location of at least a portion of the cortical visual centre in man; as in them the lesion was circumscribed and occupied nearly the same place in the occipital lobe. They would, at least, seem to settle definitely that in the cuneus and its immediate neighborhood the visual half centre for retinal sensations is located. Owing to their importance I will give briefly from Seguin a condensed abstract of these cases.

Haab's case was a man, 68 years old who had an attack of temporary paresis of the left extremities. The patient complained that he could not see to his left with his left eye—though his right eye was normal. No anæsthesia; intelligence was normal, hearing good. Central vision—1 (H.2). There was left homonymous hemianopsia, the limit reaching quite (?) up to fixation point. In the right fields color perception was good. Optic nerves presented a "senile grayish color." The autopsy showed the extremity of the right hemisphere

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* Centralb. für prakt. Augenheilk, vol. i., December, 1879, p. 254.

† Klinische Monatsblätter f. Augenheilk, xx., 141, 1882. ‡ Ibid.

§ Archiv f Psychiat, u. Nervenkrankeiten, Bd. 16, S. 166.

‖ Jour. of Nerv. & Men. Dis., vol. xiii., No. 1, January, 1886, 1–38.

¶ Am. Jour. Med. Sci., vol. xciii., January, 1887, 140–168.

5 mm. shorter than its fellow and a depression in the right occipital lobe, the pia hanging loosely over a cavity containing clear fluid. The patch was mostly upon the mesial aspect of the hemisphere (including apex). It occupied the site of the fissure hippocampi, and extended beyond it above and below. The white substance was but slightly injured.

Huguenin recorded the case of a girl, aged 8 years, whose chief symptoms were headache in paroxysms; later, frequent vomiting, sleep broken; severe convulsions which frequently recurred; increasing dementia; slight neuritis with some swelling. It was noticed after some months that the patient held her head obliquely to the left. Examination revealed left homonymous hemianopsia, the only symptom indicating a focal lesion of the brain. The patient died of broncho-pneumonia. At the autopsy two tumors were found in the brain; one at the apex of the left frontal lobe. The second tumor lay in the mesial aspect of the right occipital lobe, projecting a few mm. above the level of the brain, firmly adherent to the pia and only slightly to the dura. Its length was 3 cent., height 3 cent., thickness 2.5 cent.—mostly buried in brain substance. It lay directly over the sulcus hippocampi, extending to either side of it. The base of the occipital lobe was not involved.

Fere reported the case of a female, aged 52 years, who in November, 1883, had a sudden apoplectic attack followed by right hemiplegia. She had partial and slight right hemianæsthesia to cold and pain. Hearing, taste and smell were normal; and typical right lateral hemianopsia, the vertical line passing through the point of fixation, was present. Autopsy showed a yellow patch destroying the greater part of the left cuneus and encroaching somewhat on the adjacent occipito-temporal convolution, the fifth temporal convolution of Ecker. No other lesions were present.

Seguin reports one personal case. The patient, a man 46 years old, consulted him first in January, 1884, for insomnia and dyspepsia. He was treated for various symptoms with varying success. December 5, 1884, he had an attack in which he complained of numbness in the left cheek, arm and face, and most marked in the hand and foot. He had no distinct hemiplegia, and no hemianæsthesia, but thought that tactile sensibility as in passing his fingers over objects, was somewhat duller. He could not see objects on his turning his head and eyes, and testing revealed left lateral hemianopsia, with a vertical division line not including the point of fixation. Central vision was good. He continued with varying symptoms until May 17, 1885, when he died. During his long illness he had attacks of acute hallucinatory mania, both aural and hallucinatory illusions being present. He had chills, high fever, and sweats which followed no distinct periodicity. Previous to his death his speech was sometimes somewhat difficult to understand. The hands both showed disorders of movement, choreiform tremors, and in the left hand slight ataxia and larger motion. The hemianopsia persisted to the last unchanged. The central vision remained good. The brain lesion which doubtless caused the hemianopsia was found on autopsy to be a large focus of yellow of softening, evidently an old patch, involving the basal part of the cuneus, the fourth and fifth temporal convolutions of Ecker, and a part of the hippocampal gyre. Other lesions were present in the brain, but as this case was in harmony with others Seguin regards it very properly as of great value.

In his table in the paper referred to on cortex hemianopsia, Seguin has included five cases of traumatic hemianopsia due to injuries of the occipital region of the skull, and lesion of the subjacent brain. I will refer to only one of these cases, that of Keen and Thomson, which is of historical as well as of scientific interest. Through the courtesy of Dr. Keen, I have examined a cast of the head of this patient. The case was reported in the photographic Review of Medicine and Surgery, February, 1871; also in the Medical and Surgical History of the War of the Rebellion, Part 1, p. 206–207. It is also referred to in Flint's Physiology of Man, vol. v., p. 41–42, 1874, as one of the first cases to show that the filaments from the optic tracts on the two sides are connected with distinct portions of the retina. The patient was kept under observation off and on for a number of years, and was examined and exhibited by Dr. Seguin at the time of the reading of his paper. His hemianopsia was found unchanged twenty-three years after the reception of his injury. The patient died within a year or two, but unfortunately no autopsy was secured. He was hit on the head by a minie ball at the battle of Antietam, September 17, 1862. The wound of entrance was in the middle line 1¼ inch above the external occipital protuberance; it made its exit about two inches to the left of the middle line, and three above the wound of entrance. He noticed impairment of vision two days after the injury. About ten days afterwards he had an attack of loss of consciousness with some paralysis of the right arm and right leg, which lasted some two or three months. His memory was imperfect for some months, but he had no aphasia. In walking he was very giddy, and noise and laughter would hurt him. His mental and physical powers gradually grew better. He was seen and examined by Drs. Keen and Thomson, in December, 1870. Among other conditions he was found to have a complete lateral hemianopsia. Upon testing the field of vision it was found to be divided in each eye by a line passing through its centre in a vertical direction—total blindness existing to the right, and perfect vision to the left of this line. Ophthalmoscopic examination showed no pathological appearances. When Dr. Seguin examined this man in 1885, he presented no distinct paralysis, no anæsthesia, no aphasic symptoms. His tongue deviated a little to the right, and the grasp of the right hand was a little lighter than that of the left. A rough test with a small white object at 18 inches showed right lateral hemianopsia, with line passing outside of point of fixation, and a darkened area in the left upper temporal quadrant. Pupillary reaction was normal. Examination of the fundus showed blood vessels of normal size ; outer temporal quadrant of each disc whiter than normal ; left a little whiter than the right. An experiment on the cadaver showed that the track of the ball was such that it must have injured the optic fasciculus on its way to the cuneus.

The most important case which has been recorded since the paper of Seguin is that of Hun, in which a defect in the fields of vision involving the lower left quadrant of each eye occurred with atrophy of the lower half of the right cuneus.

The patient, a man aged 57, in 1869, had a severe attack of double pneumonia, and during the year following slight attacks of vertigo while walking, which were attributed to weakness. From 1877 until his death, he was troubled by slight deafness and by more or less roaring in his ears. In 1882 he had a large carbuncle on his neck, and after that time he seemed less vigorous than before. Early in December, 1884, he was examined by Dr. Merrill, who found normal reaction of the pupils, normal appearance of the fundus, vision and color perception perfect, but a defect in the fields of vision involving almost the whole of the left lower and the peripheral portion of the left upper quadrants in each field. The defect was somewhat more extensive, especially as regards the upper quadrant, in the left field of vision than in the right.

From this time the condition of the patient did not change materially. He continued to be very nervous, and at times irritable and suspicious. He exhibited no paralysis of motion or sensation. His memory was weak in regard to names; he often called the same person by several names in the course of conversation; while in other respects, as in recognizing faces, his memory was excellent. He slept but little, and in his sleep there was much twitching of the limbs. In 1885 he had a severe attack of angina pectoris, and for two weeks he could walk only a short distance without bringing on an attack of the pain. In

February, 1886, he had his most severe attack of angina, lasting several hours, and from this attack until his death, he was scarcely a day without pain in the precordia or in the arm. During the last month of his life he vomited often. He complained of increasing dullness of vision and of greater angle of obliteration, and was much troubled by a new building near by appearing to be out of line. On May 7, 1886, while quietly walking in the street he sank gently to the ground and died.

At a point on the median surface of the right occipital lobe was complete atrophy of the cerebral convolutions, only a trace of them remaining as a delicate gray gelatinous fringe. This atrophy was strictly limited to the lower half of the cuneus; being bounded below by the calcarine fissure, in front by the parieto-occipital fissure, and above by a curved line which started from the parieto-occipital fissure and arching backwards across the middle of the cuneus terminated at the posterior border of the median surface close to the calcarine fissure. The white matter underneath the point of atrophy was softened to a depth of about one-third of an inch. There was no deposit of pigment in the neighborhood. The corresponding point on the left occipital lobe showed no atrophy, nor did any of the other cerebral convolutions. Sections through the brain substance, the optic thalami, and the other ganglia at the base revealed nothing abnormal. The optic nerves and tracts showed no microscopic atrophy or degeneration. No microscopical examination was made.*

Views of Physiologists as to Visual Localization.

The view of Ferrier as expressed in the latest edition of his *Functions of the Brain*, is that the angular gyres maintain relations with the areas of clear vision, and as a matter of course especially with the macula luteæ.

This physiologist has modified his earlier views in so far that he no longer localizes the visual centres in the angular gyres to the exclusion of the occipital lobe; but believes now that the visual centres embrace not only the angular gyres, but also the occipital lobes which together he terms the occipito-angular regions.

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*At a recent meeting of the Philadelphia Pathological Society, I presented the brain of a man who had been blind more than twenty-five years—how much more could not be positively ascertained. Both occipital lobes were unquestionably small. The cuneus on each side was small, the first occipital convolution of Ecker (superior external pli de passage of Gratiolet, and par-occipital of Wilder) showing lack or arrest of development. The second and third occipital convolutions of Ecker, especially on the left, presented a narrow, dwindled appearance. In another brain of an old woman, blind for at least thirty years, similar gross appearances of arrested development in the occipital region were present.

Recently considerable activity has been exhibited in the investigation of visual centres.

From a long series of experiments upon the monkey's brain, on which he was engaged with Mr. Victor Horsley during more than two years, Schäfer* writes as follows :

> "With regard to vision our experiments were not conclusive. We found that extensive lesions, both of the occipital lobe and of the temporal lobe, were invariably followed by visual disturbances, taking the form, when the operation was confined to one side of the brain, of bilateral homonymous hemianopsia; but in nearly every case the hemianopsia was merely temporary, and after a certain time we could not in our monkeys obtain any distinct evidence of the persistence of the visual defect. The most marked results of this kind were obtained when the occipital lobes were the seat of the operation, extensive unilateral lesions in this region producing hemiopia, and bilateral lesions producing amblyopia; but in neither case were the symptoms permanent, and after a time the animals, so far as we were able to determine, could see as well as their intact fellows. In one case only did the hemiopia persist, and this was one in which, after a bilateral lesion of both occipital lobes had been carried out and the temporary blindness thereby produced had been recovered from, the angular gyrus of one side was destroyed. This second operation, made upon the animal in which the occipitals had already been extensively destroyed *without* permanent blindness, did produce a condition of hemianopsia which lasted until the animal's death some three months later. We were of opinion at the time that this instance might warrant us in taking up a position similar to that of Luciani and Tamburini, and intermediate between those of Ferrier and Munk—the former of whom originally denied the participation of the occipital lobe in the visual perceptive function, and still appears to regard it as subordinate to the angular gyrus; whereas the latter would localize those perceptions entirely in the occipital lobe, and deny all participation of the angular gyrus. But we made only four experiments upon these regions, and in none of them was the removal of the occipital lobe complete, as was proved by post-mortem examinations of the brains. They were not, therefore, decisive against Munk's statement, that persistent hemiopia or blindness follows extirpation of one or both occipital lobes alone, and it became necessary to pursue further inquiries in order to test its accuracy."

In conjunction with Dr. Sanger-Brown, Schäfer also experimented upon the angular gyre and upon the occipital lobes. Destroying one angular gyrus as completely as possible with the actual cautery they could discover no defect of vision, no loss of movement of the eyes or eyelids, and no anæsthesia of the corneal conjunctiva. A week later the angular gyre of the opposite was destroyed, also with negative results.

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* Brain, London, January, 1888.

In illustration of the effects produced by complete removal of the occipital lobe, and that alone Schäfer gives two instances, in one of which the operation was unilateral, in the other bilateral.

> "In the monkey upon which the unilateral operation was performed, the left occipital lobe was removed by a vertical incision carried along the line of the parieto-occipital fissure. That the removal was exact and complete was confirmed on post-mortem examination, some eight months after the establishment of the lesion, when it was seen that the whole of the occipital lobe, and only this lobe was involved, the angular gyrus being quite intact and normal, and the surface of the section looking as fresh, and showing as clearly the distinction of grey and white matter, as if the operation had just been performed. The result was the immediate establishment of bilateral homonymous hemianopsia, which persisted the whole time the monkey was kept alive. Objects so placed that their images fell upon the left half of the retinæ were taken no notice of: a threatened blow coming from the right-hand side of the mesial visual plane was winced at or avoided: currants strewn upon the floor were only picked up towards the left side, the animal working in that direction. In the case of the monkey with bilateral operation the result was total and persistent blindness."

The views of Hun* are that the convex surface of the occipital lobe, particularly of the left side, is associated with complete visual perception and recognition; and also that the so-called left angular gyre is essential for the memory of the appearance of words, lesions of it causing alexia and agraphia.

I shall not attempt to analyze, criticise or reconcile these various and varying views. They agree, at least, in showing the production of hemianopsia from lesions of the cuneus and adjacent occipital lobe.

The general visual zone, which has been determined can probably be compared as to subdivision with the general motor zone. As the motor zone has been subdivided into areas of representation, not only for the leg, trunk, arm, face and speech, etc., but also into areas or centres for parts of the leg, arm, face and speech, so efforts, partly successful are now being made to subdivide the visual zone. The retina so far as its connection with the central cortex is concerned, can be subdivided into segments probably of a somewhat regular shape. At first studies in hemiopia and hemianopsia seemed to show that the only definite connection was between the halves of the retinæ and cortical centres, but the latest observations indicate that quadrants, and probably even smaller portions of the retinal expansion are related to separate areas in the brain. The macular region almost certainly has its special cortical centre. The tendency of investigation, both experimental and pathological, is to show that the whole of the occipital lobe, and adjoining portions of the parietal and temporal lobes, are in some way concerned with vision, as I have tried to indicate in the diagram (Fig. 6).

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* Op. cit.

With reference to visual localization, the importance of confirming physiological experimentation by careful clinico-pathological observations cannot be overestimated; these observations are here even of more importance than in motor localization. The movements of a limb or a portion of a limb, can be studied with considerable accuracy in the lower animals as well as in man; but in investigating sight, the other special senses, or general sensibility, in the lower animals, we are confronted with special difficulties and sources of error. This is perhaps more strikingly true of hearing, taste and smell, than of the other senses but it is true for all. Schäfer referring to a monkey from which he believed he had eradicated both angular gyres, states that for three or four weeks the animal failed to see objects which were just below or to one side of its eyes, and even at the time of writing there appeared to be complete absence of vision in the antero-superior and lateral portions of the retinæ; but it was difficult to prove this because the monkey had acquired the habit of rapidly directing his head and eyes so as to use the central parts of the retinæ.

Operations guided by Visual Localization.

In spite of the conflict of views with reference to visual localization, sufficient has been determined to indicate several positions for operation guided chiefly by visual symptoms.

If a patient has lateral homonymous hemianopsia as the special localizing symptom, operation should be performed with the view of reaching the cuneus behind the position of the parieto-occipital fissure. If, without hemianopsia, the patient fails in intelligent recognition of things and words, the aim should be the lateral occipital convolutions and the angular gyre, which is adjacent, or indeed may be situated in the occipital lobe. When, with lateral homonymous hemianopsia, the patient also has hemianæsthesia, the lesion is probably in the tracts between the cuneus and the primary optic centres, large enough also to involve the sensory tracts. Such a lesion would probably best be reached beneath the position where, on the lateral aspect of the hemisphere, the parietal, occipital and temporal lobes come together. Hemianopsia is sometimes a late symptom, the result of invasion of the visual region from other localities; such a case will be referred to later when speaking of large lesions of the temporal lobe.

I have made various examinations of the human brain on recent as well as older specimens in order to determine, if possible, where the optic radiation proceeding from the corpora geniculata and corpora quadrigemina enter the hemisphere to proceed to the cortical centre of vision ; in part with a view of determining the relations of the angular gyrus, cuneus, and adjoining occipito-temporal region to this place of entrance, and therefore the position and direction of the intra-cerebral tracts. Undoubtedly, so far as the human brain is concerned, both the angular gyrus and the occipital lobe are so placed with reference to the geniculate bodies and corpora quadrigemina that they are anatomically and morphologically in relation with these radiations. Schäfer * gives a view of a longitudinal section of the hemisphere of a monkey which he believes demonstrates that fibres proceeding to the angular gyrus are not involved in lesions of the occipito-temporal regions. Whatever may be true of the monkey, this is certainly not true of the human brain.

Wernicke's Hemiopic Pupillary Inaction.

The great practical importance of some of the studies which have grown out of cerebral localization is seen in the fact that the simple but valuable discovery in semiology, Wernicke's hemiopic pupillary reaction, enables us with a flash of the ophthalmoscope to throw the lesion producing hemianopsia back of the primary optic centres. With a normal retina uniform pupillary reaction occurs no matter at what position the ray of light strikes upon it. Seguin † clearly explains this hemiopic pupillary reaction, or inaction, as he suggests to call it, in one of his papers on hemianopsia. In a word, the test depends upon the fact that the hemiopic part of each retina being physiologically inert, fails to receive any impulse from the light which is thrown on it. When the lesion is in the cuneus or occipital lobes, hemiopic pupillary reaction is not observed. When the lesion, producing hemianopsia involves the optic tracts, there is from an early period hemiopic pupillary inaction as well as partial nerve atrophy. A full discussion of this subject will be found in the paper of Seguin, and the original memoir of Wernicke.

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* Brain, July, 1888.

† Jour. of Nerv. and Ment. Dis., vol. xiv, November and December, 1887, 721–737, and Fortschritte der Medicin, I. Heft 2, 1883, cited by Seguin.

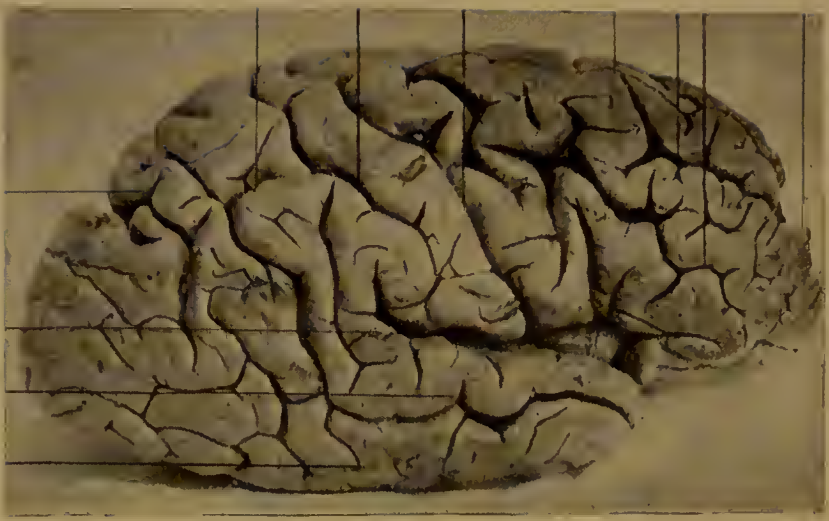

Fig. 8.—Brain of Delusional Monomaniac.

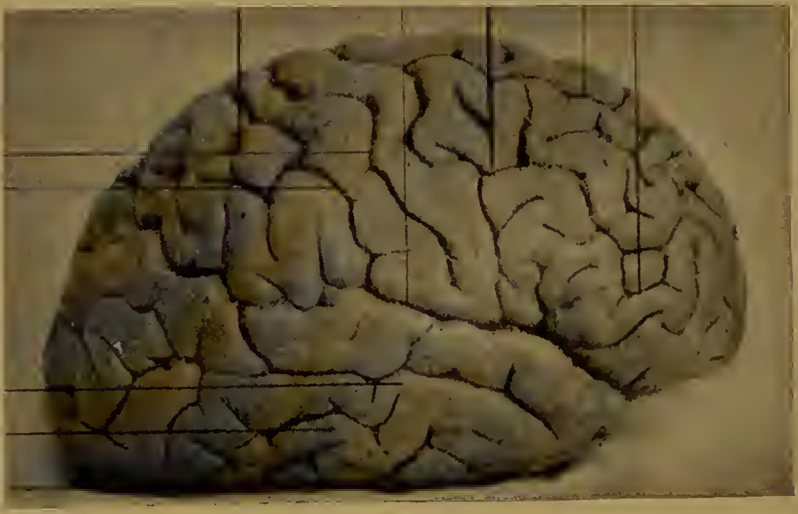

Fig. 9.—Chinese Brain.

Morphological Peculiarities of the Human Brain.

It is a question whether we are in a position for practical purposes to make any distinction between the angular gyre and the external occipital convolutions ; nor is it absolutely necessary that this should be done in trephining with a large instrument.

Morphological peculiarities of the human brain have an important bearing on this subject. In 1880,* I called attention to this matter and particularly with reference to the so-called angular gyre, referring to the brain of a white man in which the first temporal sulcus extended back of the transverse occipital and to within half an inch of the longitudinal fissure. The angular gyre is usually regarded as the arch composed of the posterior uniting portions of the inferior parietal and superior temporal gyres. It has seemed to me that these morphological aberrations are especially marked in the parieto-occipital region, so much so in some cases as to lead us to use great care in determining by external methods the position of the cerebral areas.

It will only be necessary to call attention to one or two striking peculiarities in the brains examined, mostly in the insane and in individuals of low organization.† In a case of delusional monomania, for example, the occipital fissure showed itself and in its communications and surroundings, marked ape-like conditions, such as might have been very deceptive if exposed by trephining (Fig. 8).

In the other hemisphere of the same case the cuneus was small, and the first temporal fissure presented an unusual appearance, being divided about its middle by a comparatively large gyre. In another case, in the right hemisphere, the second temporal fissure was short, and communicated with a very well defined almost vertical fissure, which separated the temporal from the occipital lobe. The first temporal, as well as the second, communicated with this fissure, the vertical extension of the first being, in fact, continuous with it. The cuneus was distinctly smaller and of a different shape from the cuneus of the right hemisphere. In another case, the first temporal fissure was remarkable in that it was completely confluent with the Sylvian, extending from the point of the confluence as a deep, well defined trench backwards and upwards nearly to the sagittal fissure, crossing and confluent with the interparietal. In a Chinese brain (Fig. 9) studied by Dr. A. J. Parker and myself, a remarkable peculiarity of the brain was that in the right hemisphere the first temporal fissure, beginning near the anterior extremity of the temporal lobe, passed backward across the entire extent of the parietal lobe and over the median edge of the hemisphere for the distance of half an inch, terminating in the precuneus just in front of the parieto-occipital fissure.

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* Phila. Med. Times, April 24, 1880, 366–370.

† Jour. Nerv. and Ment. Dis., vol. xii., September and October, 1886, 517–553.

This is an interesting field, and has some practical importance. Even the Sylvian, the central, and the parieto-occipital fissures, have considerable variations, the first in its horizontal level and extension, and the others in their antero-posterior position. I have reported one case in which the Sylvian fissure took a position much more vertical than usual and reached nearly to the longitudinal fissure. As a rule, variations, such as those referred to here, for fissures like the Sylvian, would not confuse us in operating after the methods of Broca, Thane, Reid, Horsley, and others ; but they are certainly worthy of some consideration.

Localization of Cutaneous Sensations.

With reference to the localization of the centres for cutaneous sensations—touch, pain, temperature, etc.—we are acquiring more positive knowledge and may be able in time to use such knowledge to guide in surgical operations. The evidence, physiological, clinical, and pathological is becoming stronger in favor of the existence of a zone for these general sensations separate from the motor areas.

Various, indeed, have been the views held with reference to the localization of these sensations. Luys, largely from anatomical studies, made the thalamus a centre of sensibility, subdividing it into four special centres—olfactory, optic, acoustic, and for general sensibility. Ferrier, regards the thalamus as in some way connected with sensation, but believes that differentiated areas for sensation also exist in the cortex. He holds that it is probable that the thalami are especially related to the sensory tracts, and the striate bodies to the motor tracts ; that these ganglia represent in a subordinate manner all the sensory and motor tracts of the cortex. The thalamus is a centre of conveyance, or an interrupting ganglion in the course of the sensory tracts. The experiments of Monakow led to the conclusion that different portions of the thalamus are related to cortical areas. Fournier believes that sensory fibres terminate in the thalamus. Crichton-Browne regards this ganglion as a great centre of general sensibility ; but Flourens, Longet, Schiff, and Tamburini, among others, have assigned to it motor functions. The weight of the evidence both from experiment and disease connects the thalamus with various forms of sensation. It is probably a halting place where sensory impressions going from the periphery to the cortex undergo some transformation. It is necessary, at least, briefly to thus refer the functions of the thalamus as some authorities are inclined to regard it as the sole cerebral region for sensibility.

From analogy and general principles it is altogether probable that we have above the ganglia a separate localization for the different forms of cutaneous sensibility. As Ferrier puts it, up to the point of radiation towards the cerebral cortex the sensory paths have been proved to be entirely differentiated from the motor, and it is therefore extremely unlikely that the two should become jumbled together indiscriminately in the cortical centres. We have not only the well known differentiation between sensory and motor nerve roots and tracts in the spinal cord, oblongata, pons, and crus cerebri ; but abundant evidence as to the separation of sensory from motor tracts in the internal capsule. The very simple but natural question may be asked: where do these paths lead if not to special cortical areas for sensation ? Cases have been reported by Demeaux (quoted by Ferrier), by F. Müller and others, in which autopsies have shown hemianæsthesia to result from lesion of the hinder third of the internal capsule or adjoining portions of the corona radiata.

Veyssière produced hemianæsthesia on the opposite side of the body by dividing this portion of the capsule in animals. We not infrequently see hemiplegia and hemianæsthesia united in the same patient as the result of a capsular lesion, and numerous autopsies have shown that the posterior and middle parts of the capsule are in these cases involved in a destructive lesion. Cases of hemianæsthesia from lesions both of the thalamus and lenticular nucleus have been reported, but in very few has the lesion been strictly localized to these ganglia, and even in these it is a question whether the hemianæsthesia resulting has not been due to pressure on the internal capsule.

Recently I made a post-mortem examination on a patient who died at the Philadelphia Hospital, a woman 47 years old. She had had many symptoms which were supposed to be hysterical. On the morning after her admission she had a fit or seizure, the character of which was not closely observed. Afterwards, however, she was paralyzed and anæsthetic over the right half of the body and limbs, her speech also being thick, but consciousness not lost. Partial anæsthesia was present over the left half of the body. Knee-jerk was increased, and ankle clonus was present on both sides. She improved rapidly but remained in bed two weeks. Two days before her death she had an apoplectic attack and became completely paralyzed and hemianæsthetic in the face, limbs, and trunk of the left side. The autopsy showed a foyer of softening in the right hemisphere, including the entire breadth of the internal capsule, two-thirds of the adjoining lenticular nucleus, a small anterior external portion of the thalamus, and a narrow strip of the caudate nucleus where it curves around the thalamus. Careful transverse sections showed that the anterior boundary of this focus of softening was 1¼ inches behind the head of the caudate and lenticular bodies, and that it extended from before backwards about ⅝ of an inch. It was so situated that a transverse section immediately in front of the thalamus marked its anterior boundary. The softening of the narrowed caudate nucleus was all that was observable in opening the ventricle. The left hemiplegia and hemianæsthesia might very properly be attributed to the complete transverse destruction of the internal capsule. A large recent embolus was found in the right middle cerebral artery. It is difficult to account for the temporary right hemiplegia and hemianæsthesia, except on the theory of hysteria or functional disturbance, as no lesion of the cerebral hemisphere on the left side was discovered.

The fibres of the sensory tract are probably separate from the motor even in the centrum ovale.

"The third set of fibres of the projection system," says Starr,* "includes those which lie just posterior to the motor tract, and which pass inward from the parietal convolutions. These take a similar course to those of the motor tract, and fill up to a considerable extent the space between it and the radiation of the visual tract, toward the occipital lobe. They are mingled with fibres which pass to the optic thalamus, but are separable from them, as Edinger has shown, in fœtal brains, and may be traced down through the capsule to the tegmentum of the crus, where they divide into a portion going to the leminscus, and a portion going to the formatio reticularis. This set of fibres conveys the sensations of touch, pain, temperature, and muscular sense, and lesions in its course will cause disturbance of these sensations. Like lesions in the motor tract, the rule obtains that the nearer the cortex the more likely is the lesion to cause an affection of a single limb, while the nearer the capsule the more likely is the symptom produced to be hemianæsthesia."

Ferrier in his earlier experiments found that lesions involving the horn of ammon and hippocampal convolution caused impairment or abolition of tactile sensibility on the opposite side of the body, and located the cortical centres for this form of sensibility in the hippocampal region. In experiments with Professor Yeo, in 1884, he established lesions in the hippocampal regions in ten monkeys, and in five of these in both hemispheres, and these lesions showed that tactile sensibility was in every case impaired or abolished, according to the amount of destruction of the hippocampal and temporo-sphenoidal region. It was also established, however, that a very extensive lesion might be made in one or both hippocampal regions without producing permanent anæsthesia.

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* Medical Record, Feb. 13, 1886.

Munk* claims that the area of common sensation—including sensation of pressure, location of a limb, muscular sense, and touch—lies in the central region, including the anterior and posterior convolutions and adjacent cortex. He divides this area into special centres for the hind leg, fore leg, head, eye and ear muscles, neck and body ; holding that these coincide with but are somewhat more extensive than the corresponding motor centres for these parts.

The sensations of touch, according to Luciani, are perceived in the central convolutions, and therefore lesion of these cause anæsthesia as well as paralysis. The tactile area includes the parietal convolutions also, but does not reach the occipital and temporal lobes. This author holds that all sensations appear to have a common zone in the parietal region, and lesions in this common zone may cause disturbance of all the senses.

It is worthy of remark that the physiologists and others, who contend that the sensory portion of the cortex coincides with the motor, also hold that it extends beyond into adjacent cortical regions, as witness the views of Munk, Tripier, Moeli, and others, cited by Starr in his elaborate paper.

Ferrier's explanation† of what he regards as the errors of observers like Schiff, Munk and others who believe that sensory areas coincide with motor centres, is reasonable. "The conclusion that tactile sensibility is lost or diminished after the destruction of the cortical motor area," he says, "is based on defective methods of investigation and erroneous interpretation of the reactions of the lower animals to sensory stimulation. Though an animal does not react so readily to sensory stimulation of the paralyzed side it does not follow that this is due to diminished or absent perception of the stimulus. An animal may not react, or react less energetically, to a sensory stimulus, not because it does not feel it the less, but because it is unable or less able, to do so from motor defect. It is astonishing what apathy or indifference some animals display towards certain forms of stimulation, such as gradually increasing pressure on the fingers or toes which one would regard as well calculated to elicit reaction or signs of uneasiness. Unless the stimulus is of a nature to at once excite attention, or to evoke reflex action, it may appear to be altogether unperceived. All that the experiments of Schiff and Tripier demonstrate is that motor reactions are less readily evoked on the side opposite the cortical lesion. But the same thing occurs in cases of purely motor hemiplegia in man."

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* Pfluger's Arch. f. Physiologie. Quoted by Starr, Jour. Nerv. and Ment. Dis., vol. xi., No. 3, July, 1884, 327–407.

† Functions of the Brain.

On anatomical and morphological grounds Broca holds that the callosal and hippocampal regions constitute together a distinct lobe of the brain, the falciform or limbic lobe; also I believe erroneously, that this lobe is connected entirely with the sense of smell. So far as the brain of man is concerned, in this lobe should probably be included the entire precuneus or quadrate lobule on the mesial aspect of the hemisphere and the adjoining portion of the superior parietal convolution on the lateral aspect of the hemisphere.

The most important recent contribution to cortical sensory areas, is certainly that of Horsley and Schäfer.* Hemianæsthesia, partial or complete, and contra-lateral, resulted from destructive lesions of the limbic lobe. They found that any extensive lesion of the gyrus fornicatus was followed by hemianæsthesia more or less marked or persistent; sometimes the loss of sensation involved almost the whole of the opposite side of the body; sometimes it was localized either to the upper or lower limb, or to a particular part of the trunk. They did not, however, succeed in establishing the relations between special regions of the body and the parts of the convolutions which had been destroyed.

"These experiments were frequently, but by no means in every case, complicated by the presence of a certain amount of motor paralysis, chiefly, if not entirely, affecting the muscles of the leg. We have no doubt that this condition was always due to a lesion (accidentally produced during the operation, or subsequently, as the result of interference with the circulation) in the leg-area of the marginal convolution. Now in one or two of these cases the anæsthesia affected chiefly the paresed limb, and it might be argued by those who, like Schiff and Munk, hold that the excitable areas of the cortex are concerned with the perceptions of sensory impressions from the corresponding regions of the body that the loss of sensibility was due to lesion of the motor-area. But against this argument we may not only put forward those experiments in which there has been no accompanying paralysis, but also others in which the hemianæsthesia has been well marked in the upper limb and upper part of the trunk, while the lower (paresed) limb has exhibited no diminution of sensibility whatever." * * *

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* Phil. Trans. Royal Soc., 1888.

"From which it would appear that while the whole limbic lobe may be concerned in the perception of sensory impressions, the part played by the gyrus fornicatus, at least, as regards cutaneous sensibility, is more important than that played by the hippocampal portion of the lobe. But until it has been possible entirely to destroy the whole lobe upon both sides of the brain it is impossible to determine whether it is assisted in its functions by any other portion of the cerebral cortex." * * *

"The results of our experiments upon the limbic lobe seem to point to the conclusion that this portion of the cerebral cortex is largely, if not exclusively, concerned in the appreciation of sensations, painful and tactile. This is an extension of the view put forward by Ferrier, who was inclined as the result of his own experiments, to limit that function to the hippocampal region. Dr. Ferrier was good enough to assist at some of our experiments upon this part, and has fully accepted the conclusions to which they point."

Starr, from a series of American cases of cortical lesions of the brain,* and also from a study of the sensory tracts,† concluded that the various sensory areas lie about and coincide to some extent with the various motor areas for similar parts; that, in other words, the Rolandic region is a sensory-motor region, the sensory area, however, including to some extent the gyres of the adjacent postero-parietal lobe. Collections of cases such as these cannot, however, overcome positive evidence of decided destructive lesions of the cortical motor centres, without any disturbance of touch, pain or temperature, or even of the muscular sense; and a close study of the cases of cortical lesion in which both motor and decided sensory phenomena have been present, will not bear out fully the view of Starr.

One of Starr's tables contains 41 cases showing cortical lesions of the brain with sensory symptoms. That the sensory area lies about the motor region might even from these cases be conceded, but that the two coincide has been by no means proved, particularly if the postero-parietal region is not regarded as a necessary part of the motor area. Reviewing the 41 cases, in only one-fifth to one-sixth are the lesions restricted to parts of the brain in front of the central fissure, although in many of the others both the anterior central and posterior central gyres are involved. In more than 30 of these cases the reported lesions involved in part or whole the postero-parietal region, and posterior central gyre. Four of my cases are included in the table, and this has led me to look over not only these but also other of my cases of cortical lesion with sensory phenomena; and from doing this the conclusion has been reached that they do not support the doctrine that sensory and motor areas entirely coincide.

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* Am. J. M. Sc., Phila., 1884, n. s., lxxxvii., 366–391.

† Jour. Nerv. & Ment. Dis, vol. xi., No. 3, July, 1884, 327–407.

In the case of a fibroma which involved the first and second frontal gyres, and anterior segment of the gyrus fornicatus and corpus callosum, anæsthesia of the conjunctiva, with conjunctivitis and corneitis were present. In a patient with a gumma involving the upper fourth of the pre-central and a smaller segment of the post-central gyre, hyperæsthesia was marked, with also crural Jacksonian epilepsy, but the lesion grazed the sensory area. A carcinoma of the middle portion of the posterior central gyre and the upper part of the inferior parietal lobule was accompanied with wide-spread destruction of the corona radiata, and impaired sensibility of the limbs of the opposite side with other phenomena was present. Owing to the posterior extension of this growth and the large sub-cortical destruction, this lesion could certainly not be claimed to teach anything with reference to the coincidence of motor and sensory areas. In another case of tubercular tumor in the motor area, the interior of the hemisphere was broken down, and hemianæsthesia, at first partial but later complete and persistent, was present.

Numerous observations have shown me that hyperæsthesia is a common phenomenon in cases of diffused cortical tubercular meningitis, and this hyperæsthesia may involve any or all the extremities or the face. This fact is not to be explained as simply from irritation of the pia mater; for, on the other hand, I have observed cases of localized lepto-meningitis in which both hyperæsthesia and even pain in the head were absent. Such cases also cannot be fully explained by tubercular deposit in and inflammation of the dura mater. Although dural meningitis may cause headache of great severity and sensory phenomena in the domain of the fifth nerve, it should not be held responsible for hyperæsthesia of the extremities. The hyperæsthesia in these cases is best explained by irritation of sensory cortical areas.

Bernhardt * has recorded the case of a woman, 41 years of age, who after an apoplectiform attack had hyperæsthesia of both lower extremities; also paresis of the right arm, lower face, and foot; spasm involving the right hand, arm, and face; weak reflexes of the right leg; confusion, excitability and aphasia. The lesions were a tubercular growth in the upper extremity, lateral and median portion of the left posterior central convolution and in the precuneus; a similar growth in the middle portion of the posterior central gyre; and a tuber-

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* Arch. f. Psych., iv., Heft 3, 1874.

cle the size of a pea at the anterior extremity of the corpus striatum. The hyperæsthesia in the lower extremities might be explained by the tumor in the great median fissure. Hitzig* quotes from Löffler, the account of a soldier who received a gunshot wound on the top of the head, the dura mater being pressed inward by the depressed bone at a point which corresponded with the upper ends of both central gyres. Both legs were hyperæsthetic and also paralyzed. Such symptoms can be explained by pressure on the paracentral gyres of both sides, and direct or inflammatory irritation of the neighboring sensory cortex below or behind.

Bramwell † has reported a case of incomplete paralysis of the left extremities and of the face, with disturbance of sensation of both the arm and leg ; with also atrophy of both optic nerves and other sight disturbances. The autopsy revealed a tumor with softening of the surrounding brain in the right superior and middle parietal convolutions, and a part of the first occipital convolution.

Brill ‡ records the history of a patient with right-sided anæsthesia and paresis, the former more marked than the latter. In a few weeks hyperæsthesia developed, with also restlessness, tinnitus, beclouded mind, slight amnesic aphasia, and color blindness, the patient not being able to tell green from red, although his field of vision was not limited. A triangular focus of softening was found in the left cuneus, most of the cuneus being involved.

Fortunately I had the advantage a few hours before delivering this address of hearing one of the best papers yet written on the cortical localization of cutaneous sensations, read by Dr. C. L. Dana before the American Neurological Association, and since published in the Journal of Nervous and Mental Disease for October, 1888. Dr. Dana discusses the three views with reference to this localization : (1) That the centres for these senses are entirely separate from motor areas. (2) That the cutaneous sensory centres are more or less identified with the motor centres ; and (3) That both the motor zone and the limbic lobe are concerned in the representation of cutaneous sensation. His paper deals principally with pathological and clinical data. Altogether he collected 142 cases, including four personal observations. He concludes, among other things, that the clinical and pathological evidence collected by him shows that the motor areas of the cortex contain also the representation of cutaneous sensations ; and that cutaneous anæsthesia of organic central origin is always limited to or more pronounced in certain parts. The same objections apply to most of his cases as indicated for those of Starr.

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* Op. cit.

† Lancet, September 4, 1875, ii., 346.

‡ N. Y. Med. Record, vol. xxii., 1882, July 15, 81–82.

Dana collected for this paper 20 cases in which the gyrus fornicatus or hippocampal convolution were more or less involved, and in none of these, he says, was any anæsthesia present that could be fairly attributed to the lesion. Even a casual study of these cases seems to me to show their weakness for the support of the position taken that the limbic or falciform lobe is not concerned with sensation. In nearly one-third of these cases some disturbance of sensation was present. Three of the remaining cases were demented, and presumably any investigation into cutaneous sensation would have but little value; one case presented no symptoms.

What Ferrier says of defective methods of investigation and erroneous interpretation of the reactions of the lower animals to sensory stimulation may be applied with some additions to the study of cutaneous sensation in cases of cerebral disease in man. Numerous sources of error are present, not only in investigating but also in reporting the results of investigation.

To test cutaneous sensibility requires time, patience, and method. It is often tedious and monotonous; but it must be done carefully or the results, particularly for tactile sensibility, are worthless. Patients cannot often be depended upon, as with reference to such tests the greatest differences in the personal equation are found. Some patients have a fashion of stopping to think or weigh their answers when being tested for cutaneous sensation. This often renders the answers worthless; the response should be given promptly.

One of the commonest methods of investigating cutaneous sensibility is that of Weber, which depends upon the fact, or the alleged fact, that the distance apart at which two points can be discriminated is much the same for the same local areas in different individuals. Tables have been published which are supposed to show the least normal distances at which two points can be distinguished. This method, if very carefully applied, is sufficiently correct for many cases, but often the results obtained from such testing are utterly worthless. I have known not only patients with real or alleged loss of sensation, but perfectly healthy individuals to give diverse and confusing answers when tested with the æsthesiometer. Some of the records of the presence of anæsthesia or analgesia in reported cases have doubtless been made improperly as the result of carelessly testing the power of the patients to discriminate between two blunt or sharp points.

Another source of error, particularly in recording cases, is in deciding that objective insensibility exists from the statements of the patients with reference to their feelings. Whatever may be the explanation, it is true that many, though by no means all, patients suffering from motor paralysis the result of a cortical or sub-cortical lesion, complain of certain parasthesias. Spontaneously, or in response to questioning, they will refer to a paralyzed member, or a portion of it, as feeling heavy or numb, or cold, or as if asleep; but often in these cases careful and elaborate testing for true depression or loss of sensation will fail to reveal its presence in the slightest degree. I have been for some time engaged in minutely studying cases of hemiplegia, monoplegia, and aphasia with a view of determining in the most detailed manner the exact movements, or forms of speech, impaired or abolished, and also whether or not in these cases localized defects of sensation were present. The investigation is a clinical study in localization, the value of which will be much enhanced by the number of autopsies obtained in the cases studied, but even without such autopsies some results both curious and valuable can be obtained. A single case will serve to illustrate the point which I wish to make about some sensory investigations and records. A young man, with a history of rheumatism, and several heart murmurs, was admitted to the Philadelphia Hospital three weeks after a sudden attack of right-sided hemiplegia with aphasia. On admission he had recovered almost entirely from the paralysis of the arm and leg, but decided facial paralysis and slight aphasia, or rather ora-lingual paresis, were still present. His motor symptoms were studied with minuteness and will be published in a paper in course of preparation. On inquiring as to sensory disturbance he said that he had had for several days some pain in the leg and arm, and a feeling of numbness or as if the parts were asleep, in the right face, arm and leg. This sensation had disappeared entirely from the leg and arm with the abatement of the motor paralysis, but he still complained of decided numbness in the right cheek. The most careful tests were made as to the senses of touch, pain, and temperature, but not the slightest loss could be determined. He was examined by gently touching the cheek with the finger and a feather, with blunt and sharp points, with hot and cold water, with different weights and different amounts of pressure, and by the method of Oppenheim, namely, that of touching symmetrical spots on both sides of the median line at once, and observing whether he appreciated the touch on both sides equally.*

* The patient recently died. At the autopsy, a focus of strictly cortical, yellowish softening was found involving the lower extremities of the central convolutions both on their external and Sylvian surfaces, and a spot one-half an inch in diameter about the middle of the internal portion of the island of Reil. The softening reached into the

Some light has been thrown on the disputed question of the existence of sensory centres in the motor cortex by careful examinations of patients after operations, particularly when definitely determined gyral areas have been cleanly excised. In one of Horsley's cases, in which the scar tissue and surrounding healthy brain substance was excised, after the operation the patient had at first, coupled with some motor paralysis, a loss of tactile sensibility over the dorsum of the two distal phalanges of the fingers, and could not tell the position of any of the joints of the fingers, thus showing apparently some loss of tactile and muscular sense ; but as Horsley remarked it was possible that some of the fibres of the corona radiata coming from the gyrus fornicatus may have been injured. Both motor and sensory paralysis disappeared in the course of two months.

In Weir and Seguin's case of right-sided Jacksonian epilepsy and paresis—in which a small sarcomatous growth was cut out of the white substance below the posterior edge of the second frontal, and the anterior edge of the pre-central gyres—careful tests were made over a period of nearly seven months after the operation. They showed at first slight apparent dulness of tactile sensibility in some parts ; retention of pain, and temperature, and muscular sense, with motor paresis and speech defect. In later tests the patient no longer felt numb ; could tell the lightest touch on the fingers and hand ; and with eyes closed could distinguish consecutive contacts with a coarse bed cover, a thin handkerchief, and a sheet of paper ; he could also recognize slight difference of weight. Nearly seven months after the operation co-ordination of the hand was perfect ; the patellar reflex normal and equal on both sides; there was no wrist reflex ; the senses of touch, temperature normal ; he could distinguish differences of weight of only a few grains, and was fully conscious of all passive movements.

In the case of Lloyd and Deaver, also one of brachio-facial spasm and paresis, reported at the meeting of the American Neurological Association during the session of the Congress, no gross lesion was found, and the facial and arm centres were carefully excised, with a resulting cure of the spasms. On several occasions, with Dr. Lloyd, I tested the conditions as to motor power, sensibility, and the reflexes in this patient, with results which have been reported by Dr. Lloyd.

fissure of Rolando, and also into the precentral fissure, taking in a posterior, inferior strip of the second frontal convolution. Its greatest height was 1¼ inches upward from the Sylvian fissure, its width along this fissure was 1¼ inches. The lesion did not reach to the anterior branch of the Sylvian fissure, its anterior limit being one-fourth of an inch behind this fissure.

This patient blindfolded could instantly recognize the slightest touch on all points of the affected side; even light breathing upon his hand was at once detected; pain and temperature sense were normal; and he could discriminate between weights. If objects were placed in his paretic hand he often failed to recognize what they were, but apparently because he was not able easily to grasp and run his fingers over them and thus take in their form and bulk.

These experiments, which should be repeated with the greatest care whenever opportunity offers, seem to uphold the doctrine of pure psycho-motor centres rather than the sensory, motor or mixed theory. They certainly are not in accord with the view that the motor zones contain centres of the muscular sense; or that they are areas for pathic or thermic sensibility, or places of confluence of excitations, or centres acted on at a distance by inhibition. The temporary disturbances in sensation may be due sometimes to destruction of association fibres between related sensory and motor areas.

Bechterew* maintains with reason that the loss of sensation in animals who have had the motor area of the convolutions destroyed is apparent and not real; that they cannot withdraw the irritated extremity though they feel the pain, because they have no control of the muscles. He also considers the loss of the muscle sense only apparent because if the animal's paws be placed in an uncomfortable position, its failure to be removed is due to motor inability rather than impaired muscle sense. The animal will move away if irritated on the affected limb, thus showing that it feels but cannot withdraw the limb except by moving the entire body. He concludes that tactile sensation is behind and external to the motor area, and the centre for muscle sense and pain is at the beginning of the fossa of Sylvius.

In several cases of surgical operation on lesions of the motor zone, it has been claimed that the presence of sensory symptoms supports the opinion that the motor areas subserve a sensory as well as a motor function; the case of Macewen,† for example, of proto-spasm of the hallux preceded by sensory impressions and followed by paralysis, in which a tubercular nodule, was found in the upper part of the post-central gyre. Such a case may prove contiguity but not coincidence of motor and sensory areas.

The neurologist and surgeon must therefore depend on motor symptoms alone in fixing the site for operation in cases in which motor symptoms are definite. When positive sensory symptoms are present, they should regard these as indicative of the extension of the lesion towards either the limbic lobe, or the posterior parietal convolutions; or the involvement of the fibres going or coming from these gyres in the corona radiata.

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* Neurol. Centralbl., Leipz., 1883, ii., 409–414.

† Lancet, Lond., August 11, 1888.

We have no clinical or pathological data with reference to the so-called muscular sense of positive practical value to the physician or surgeon. The hypothesis that the cortical motor zone is rather a zone for muscular sense has little to support it either in physiology or in clinico-pathology. I can see no reason for requiring a muscular sense entirely distinct from other acknowledged forms of sensibility. Some facts have been brought forward which are supposed to indicate that a separate cortical area for registering impressions of muscular sense exists in the parietal lobe behind the motor zone, probably in the inferior parietal lobule; but these observations are not convincing; they certainly cannot yet be made of value in topographical diagnosis for surgical purposes.

The conclusion is warranted that there is a region for general sensation, including touch, pain, temperature, and possibly pressure, and location of a limb, which can be divided into special sub-areas for the various distinct portions of the body, and that these regions lie along side of and have close anatomical and morphological relations with corresponding motor areas, but that they are not identical with them. From an anatomical and morphological point of view, and from the facts of physiology and pathology, no part of the brain is more likely to contain these differentiated areas for sensation than the gyrus fornicatus, the hippocampal gyre, the precuneus, and the postero-parietal convolutions.

The Pre-frontal Lobe and the Cerebellum.

For the pre-frontal lobe and the cerebellum our diagnostic guides are gradually becoming more definite. We may not be able with the same absolute confidence from positive symptoms and signs to indicate lesions in these localities as we can point to the motor and visual zones, but we often can make the topographical diagnosis with sufficient certainty even for surgical purposes by combining various modes of investigation, as: (1) By a few positive localizing symptoms; (2) By the general symptoms—such as, in brain tumor, for instance, choked disc, secondary atrophy, headache, vomiting and vertigo; (3) By excluding lesions of the motor, speech, visual and auditory areas, and their association tracts; (4) By special pressure and invasion symptoms—invasion by lesions growing from adjacent areas to those under consideration.

Lesions of the prefrontal lobe, although this is one of the so-called latent districts of the brain, have in a large percentage of the carefully studied cases shown distinctive manifestations. The symptoms are largely psychical, and unfortunately the physician is not usually well trained to study such phenomena. Mental disturbances of a peculiar character occur, such as mental slowness and uncertainty, want of attention and control, and impairment of judgment and reason ; closely studied, the inhibitory influence of the brain both upon psychical and physical action is found to be diminished. Memory is not seriously affected although a continuous train of thought cannot well be followed, and complex intellectual processes cannot be thoroughly performed. The results of experiments upon lower animals have not been very helpful towards determining the existence of prefrontal lesions, because psychical phenomena cannot be studied with accuracy in animals below man. Ferrier,* however, found after removal of the prefrontal lobe a decided alteration in the behavior of animals, difficult precisely to describe. They had apparently lost the faculty of intelligent observation. Horsley and Schäfer,† Hitzig,‡ and Goltz § have also observed apparent mental changes. Phenomena such as these do not measure in usefulness for the average diagnostician with such positive objective manifestations as hemianopsia or Jacksonian spasm, but they should be valuable aids in the hands of close observers. Among pressure and invasion symptoms motor aphasia, nystagmus, contra-lateral paresis, and unilateral convulsions often occur late, particularly in cases of tumor and abscess. Given these symptoms, if now lesions of motor and visual regions can be excluded, it remains only to differentiate the lesions of the cerebellum and possibly some lesions of the temporal lobe.

In cerebellar cases, as shown by the studies of Nothnagel,‖ Seguin,¶ and others, the most positive symptoms are usually choked discs, optic neuritis or secondary atrophy, occipital headache, sometimes increased by percussion or pressure on the occiput or neck, vomiting, often apparently causeless in character ; typical cerebellar titubation, or other disorders of motion or gait ; nystagmus and conjugate deviation ; and among pressure symptoms one-sided paresis, occasional anæsthesia, sometimes disturbance of temperature, pulse, respiration, and deglutition.

Some lesions of the cerebellar hemispheres as in cases reported by Hun ** give no localizing symptoms.

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* Functions of the Brain. † Op. cit. ‡ Quoted by Ferrier.
§ Quoted by Ferrier.

‖ Topische Diagnostik der Gehirnkrankheiten, p. 78. Berlin, 1879.
¶ Jour. Nerv. & Ment. Dis., vol. xiv., No. 4, April, 1887, 217–235.
** Albany Medical Annals, May, 1888.

It might be of value to attempt a contrast of the usual symptoms produced by lesions in these localities. In pre-frontal disease psychic symptoms of the peculiar character just described, are usually present; in cerebellar affections they are as commonly absent, although irritative lesions of any part of the encephalon may, of course, cause emotional mental disturbance. The station or gait is not affected in pre-frontal cases : in cerebellar lesions, either typical titubation or some form of ataxia or staggering is usually present. Cerebellar titubation is characteristic of a destructive lesion of the middle lobe of the cerebellum, and when lesions of the cerebellar hemispheres are present, this results from pressure or encroachment. Bulbar symptoms and symptoms of pressure on the bulbo-spinal tracts, both sensory and motor, are somewhat frequently present in cerebellar lesions, particularly late in the history of a lesion of large size. With pre-frontal lesions of large size, the pressure and invasion symptoms are more likely to be disturbances of speech or smell, facial, brachial, or aural paresis, and unilateral spasm. Carefully recorded cases show that nystagmus, and conjugate deviation may be present in both pre-frontal and cerebellar cases ; but in the pre-frontal cases the latter is more likely to be towards the side of the lesion presumably destructive rather than irritative ; in cerebellar cases more probably the reverse. Headache is more likely to be frontal in the pre-frontal, and occipital in the cerebellar. Elevation of local surface temperature, and tenderness on percussion, have some, but no great value in differentiation.

Auditory Localization.

While auditory localization remains in a somewhat uncertain state, on the whole, the evidence is in favor of the localization of the cerebral centres or area, of hearing in the temporal lobe, and probably in its upper portion, that is, in the first or second, or in both the first and second, temporal gyres. The most recent and interesting discussion of this subject has arisen from the reports of the results obtained by Schäfer in his experiments on special sense localization in the cerebral cortex of the monkey. Dr. Ferrier * in reviewing the paper of Prof. Schäfer, attacks the results obtained and the conclusions drawn by the latter, and contends stoutly for the localization of the centre of hearing in the temporal lobe, and in accordance with his original view, more especially in the superior convolution of that lobe. Dr. Starr, in his consideration of aphasia, will doubtless discuss at length the question of auditory centres, naming centres, speech association tracts, and speech centres, and I will, therefore, only briefly and for the purpose of completeness refer to this portion of the subject. Schäfer claims to have more or less completely destroyed the superior temporal gyre on both sides in six monkeys, and in one of the animals to have removed every trace of the convolution on both sides. In these cases he reports that hearing was not permanently affected, so far as it is possible to determine in monkeys, and concludes that the auditory faculty is not localized in the superior temporal convolution. In one experiment of Horsley and Schäfer, the superior temporal convolution was almost completely removed on both sides; in this case the animal appeared to hear quite distinctly, so far as it went the experiment being at variance with the results of Ferrier and those of Munk. The experimenters, however, say that they do not claim to have obtained direct corroboration or refutation of the views of Ferrier, but regard the question as still open.

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* Brain, January, 1888.

Ferrier reaffirms his position, and reproduces with some additional facts, his original experimental evidence in favor of auditory localization in the temporal lobe, and particularly in its superior convolution. Munk, who is quoted both by Ferrier and Schäfer, extended the area for perception of auditory impressions over the entire temporal lobe; and Luciani believes that lesions of the temporal lobe in dogs produce abolition or impairment of hearing.

Gowers* refers to an interesting case of extensive tumor in which the oldest part was beneath the first temporal convolution. In this case convulsions, commencing by an auditory aura referred to the opposite ear, were a very early symptom. In another case of tumor of the first temporal convolution and Sylvian fossa, unilateral convulsions were preceded by a loud noise as of machinery. He notes that the loss of deafness in such cases is not permanent; that perfect compensation seems to be possible, presumably by the corresponding centre of the opposite side; and that each auditory nerve must be structurally connected with both hemispheres, although only the connection with the opposite hemisphere is habitually in functional action.

The pathological evidence with reference to the existence of auditory centres is not extensive or very decisive. That complete deafness from cerebral disease may occur probably requires, as Ferrier states, the existence of symmetrical lesions in both temporal lobes. It has, however, been clearly established by reported cases, that the so-called word-deafness may result from lesion of the upper convolution or two upper convolutions of the *left* temporal lobe. Cases in which the power to understand spoken words has been lost or impaired with lesions, in part at least, in the temporal lobe have been reported by various observers as, for instance, by Seppilli, Monakow and Amidon.

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* Manual of Diseases of the Nervous System, p. 454.

Ferrier * refers particularly to two cases in support of his position, one reported by Shaw† and one by Wernicke and Friedlander.‡ Shaw's case, a woman, aged 34, two months before her admission into his asylum, lost power in the right arm, and soon after had a sudden apoplectic seizure resulting in loss of speech and deafness. The loss of power in the right arm soon passed off. She became incoherent, more or less maniacal and demented. On admission she was found to be perfectly deaf and blind. She died of pneumonia a year afterwards. Post-mortem examination showed complete atrophy of the angular gyri and superior temporo-sphenoidal convolutions of both hemispheres. The gray matter of the atrophied regions had entirely disappeared, leaving the outer layer attached to the pia mater, with a cavity underneath formed at the expense of the gray matter. The cranial nerves were normal in appearance, the optic nerves showed increase of the connective tissue septa, atrophy of the nerve fibres, and spaces filled with a colloid-like material.

Wernicke and Friedlander's case, a woman, aged 43, had never suffered from deafness or affection of vision, and was attacked June 22nd, 1880, with right hemiplegia and aphasia. She remained in the hospital until August 4th, when she was discharged. At this time the patient could speak but unintelligibly, and was sometimes believed to be intoxicated. She not only could not make herself be understood but she could not understand what was said to her. She was received into the hospital again on September 10th, with slight paresis of the left arm. The right hemiplegia had entirely disappeared. The patient was looked upon as insane, and was absolutely deaf so that she could not be communicated with. She died of an attack of hæmatemesis on the 21st of October. An extensive lesion was found in each temporal lobe, invading the superior temporal convolution on both sides. The rest of the brain and the cranial nerves exhibited no abnormality. It was proved that the patient had previously enjoyed excellent hearing. Her total deafness occurred rapidly in connection with the other indications of cerebral disease.§

* Brain, xii., London, April, 1888, p. 18.

† Archives of Medicine, Feb. 1882.—Abstract in Brain, vol. v., 1882–83, p. 430.

‡ Fortschritte der Medicine, Band I., No. 6, March 15, 1883.

§ With Dr. Roland G. Curtin, of Philadelphia, I exhibited at the Philadelphia Pathological Society, the brain of a man for many years a deaf mute. A description of this brain, with illustrations, will be published with the reports of some other specimens referred to in this paper, in a forthcoming number of the University Magazine. On

Large Lesion of the Temporal Lobe.

With a large lesion of one temporal lobe, as tumor, hemorrhage or abscess, the diagnosis is best made by a careful consideration of pressure and invasion symptoms in addition to those which are strictly localizing in character. A single case recently published by Dr. Bodamer and myself, will perhaps best illustrate this mode of diagnosis. The chief symptoms were severe headache, more localized in the temporo-frontal region; pain on localized percussion; impairment of sight and hearing; choked discs; dilatation of the right pupil, and three days before death paralysis of the left arm and paresis of the left leg, and aphasia. The autopsy showed a large lesion centred in the middle of the right second temporal gyre; it was a vascular glioma, having beneath and partly around it a cavity containing detritus, and a large and evidently recent clot. It occupied a large portion of the interior of the right temporal lobe, but was strictly limited to it.

Macewen reports an operation on a somewhat similar case, of a lesion definitely localized in the temporo-sphenoidal lobe. A patient exhibiting symptoms of cerebral abscess had, on the left side ptosis, stabile mydriasis, paresis of all the ocular muscles, with the exception of the external rectus, without external squint; on the right side, paralysis of the facial muscles, which retained emotional expressions to a slight degree, and power to close the right eyelid by an effort of will, although it remained partially opened during sleep. He had, also, paresis of the right arm, which during the few hours he was under observation before operation, had amounted to distinct paralysis. The leg remained normal, and there was no diminution of cutaneous sensibility.*

the whole, the gross appearances could be regarded as favoring strongly Ferrier's auditory localization. The first temporal convolution of the left hemisphere was narrow and lacking in gyral elaboration; it was apparently distinctly atrophied or arrested in development. The first temporal convolution of the right hemisphere was smaller than usual, but it did not present the marked smoothness and diminution in size shown by the corresponding convolution of the other side. The brain was compared directly with half a dozen other specimens, normal and abnormal, and was examined by several brain anatomists and morphologists, who agreed with me as to the striking appearance of lack of development of the first left temporal. Other peculiarities of the temporal, third frontal, and central convolutions, the island of Reil, etc., were noted, and will be given in the description of the specimen.

* While this paper is passing through the press, through the courtesy of Dr. H. C. Wood, of Philadelphia, I have had the opportunity of seeing a case of large lesion of the right temporal lobe which shows how active symptoms of such lesions may be absent for a long period, or if present how they may differ from the pressure and invasion symptoms in the two cases above given. Dr. Wood will publish a full account this interesting and important case. The patient had had for many months general

Tumor of the Facial and Auditory Nerves.

At the meeting of the Neurological Society, of London, March 15, 1888,* Dr. Sharkey read notes and showed the brain of a case of tumor of the auditory nerve. During the discussion of this specimen, Mr. Horsley stated that the tumor might have been removed by an operation he had already advocated—namely, incision of the tentorium and ligature of the lateral sinus. I have made two dissections with a view of determining whether a tumor in the intra-cranial course of the facial and auditory nerves can be removed, and have concluded that it could, and best, not by operating above the tentorium as I understand Mr. Horsley's suggestion, but by operating below the tentorium, and then pushing aside or excising an outer segment of the cerebellar hemisphere.

Olfactory Localization.

The location of the cortical centre of smell is still uncertain, but the pointings are all towards the region of the uncinate convolution and its immediate vicinity. Zuckerkandl, of Gratz, in 1887, published a monograph on the olfactory centre, the work being anatomical and physiological, not clinical. The anatomical portion is largely comparative, considering the brains of twelve varieties of animals besides man. One chapter describes the cornu ammonis region, another the olfactory lobes of animals and man, etc. The writings of Burdach, Treverinus, Huguenin, and Ferrier are largely quoted. Zuckerkandl

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symptoms of brain tumor, such as headache, choked discs, vertigo, etc., but no paralysis; and no loss of hearing that could be detected by ordinary tests. During the absence of the patient from the city, left homonymous hemianopsia developed, with pronounced contraction of the other visual fields. Wernicke's hemiopic pupillary inaction was carefully tested for, but was certainly not present. Operation was performed by Dr, D. Hayes Agnew for Dr. Wood, and a cyst in the right occipital lobe was discovered and removed. After death a large fibro-glioma was found occupying almost the entire second and third temporal convolutions, and also invading the central portion of the first temporal, the superior aspect of which was somewhat flattened by pressure. The fourth and fifth temporal convolutions were apparently not greatly encroached upon, the uncinate convolution escaping entirely. The patient had no loss of smell. The occipital cyst was evidently a radiation or a secondary result of the growth, due to softening from obliteration of blood vessels. This case emphasizes the great importance of carefully studying pressure and invasion symptoms with reference to such comparatively latent regions as the temporal, (particularly the right temporal), and pre-frontal lobes. The pressure in this case was evidently not exercised in the same direction as in the two cases referred to above. In a lesion of a so-called latent region, the pressure and invasion symptoms will depend both upon the nature of the growth, and on the particular direction in which it happens to develop.

* Lancet, London, April 7, 1888.

believes, but, I think without reason, that the entire limbic lobe is the seat of olfactory sensation. Among other cases, he has collected two in which infants born without the olfactory lobe on one or both sides, showed arrested development of the horn of Ammon, and in both of which the gyrus fornicatus and hippocampus were small.

Zuckerkandl, in this view, is simply following Broca, who divided all animals into osmatics and anosmatics, or good smellers or bad smellers, and believed that the whole of the falciform or limbic lobe was the cerebral organ of smell. I cannot here go into the anatomical and physiological arguments bearing upon this subject. To one familiar with brain anatomy a knowledge of the relatively large size of the gyrus fornicatus and hippocampal region in an animal like man, in whom the sense of smell plays so comparatively an unimportant part, is an argument of some weight against the view of Broca. In osmatics, however, the hippocampal lobule or region of the amygdala—the uncinate convolution so-called—is very large while in the anosmatics it is comparatively small. Ferrier's view is therefore probably correct that the only relationship which undoubtedly exists is between the olfactory bulb and the anterior portion of the hippocampal convolution. The anterior commissure has an anterior and posterior division, which connect respectively the olfactory bulb and the region of the hippocampal lobule and nucleus amygdala, a fact which also tends to prove that the anterior portion of the hippocampal convolution is the cortical organ of smell.

Electrical irritation of the hippocampal lobule or uncinate gyrus in monkeys, cats, dogs, and rabbits furnished Ferrier with significant indications of subjective olfactory sensations. This reaction, the same in all, as described by Ferrier, was a peculiar torsion of the lip and nostril on the same side. The experiment in which Ferrier produced destructive lesions of the hippocampal lobule, were, on the whole, unsatisfactory, but to a certain extent supported the view that this region contained the centre for smell.

Few autopsies have been recorded in which loss or diminution of smell has been present as the result of cerebral lesion. Ferrier, however, refers to cases reported by W. Ogle, Fletcher and Ransome, of the occurrence of the loss of smell in the left nostril with right hemiplegia and aphasia; and he also alludes to cases reported by Hughlings Jackson. From a study of these cases he believes that we have reason to regard anosmia as probably due to softening of the region of the hippocampal lobule. The connections of the olfactory tract are with the hemisphere on the same side. In some cases of cerebral hemianæsthesia, as in the hysterical and alcoholic forms, impairment or loss of smell is present and seems to be contra-lateral. This, Ferrier believes, may be explained on the supposition that the defect was due to an anæsthetic condition of the nostril, either from lesion of the fifth nerve or of the centres for cutaneous sensation in the cerebral hemisphere. Close testing in such cases would probably show that the olfactory sense was not absolutely abolished.

Various cases have been reported with autopsies in which the presence of an olfactory aura has been accompanied by a lesion of the temporal lobe, and these cases, on the whole, point to the lower convolutions of this lobe as the probable seat of the centre of smell.

Hughlings Jackson has written various papers showing the great importance of studying all forms of aura in order to be able better to localize the lesions in the encephalon. As early as 1876, and again in 1879, he considered the varieties of epilepsy in which not only crude sensations or warnings of smell, taste, etc., were present, but also a more elaborate mental condition which he speaks of as the "dreamy state." As theoretical as such discussions may seem at first sight, he clearly shows that they are of practical value not only in leading to an early recognition of epilepsy, but also in localizing lesions in either epileptic or epileptiform cases.

I have had several epileptic patients in whom the attacks were initiated by an odor usually offensive. Jackson* gives interesting histories of three such cases in which attacks were ushered in by a crude sensation warning of smell, accompanied sometimes by other warnings as epigastric sensations, and the dreamy state. These cases are of great clinical interest but are not accompanied by autopsies. He refers, however, to the necropsy of a woman who had had paroxysms with the dreamy state and crude sensation warnings of smell. She had left hemiplegia and double optic neuritis. The autopsy showed a tumor in the right temporo-sphenoidal lobe.

Allan McLane Hamilton† has reported the following case of softening of the temporo-sphenoidal lobes, in a woman of forty years. The patient suffered from the age of ten from epileptic attacks, which occurred four or five times a year, and consisted of general convulsions. The first attack occurred after a fall when she struck her head, and was unconscious thereafter for some hours. No scar was visible on the head. She always had an aura of a peculiar character before the attack. She suddenly perceived a disagreable odor, sometimes of smoke, sometimes of a fetid character, and quite uncomplicated by other sensory warnings. She died of phthisis.

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*Brain, July, 1888.

† Am. Jour. Med. Sci., April, 1884. Quoted by Starr.

On post-mortem examination the dura mater was thickened and opaque in spots, and at the base was adherent to the temporo-sphenoidal lobes. The adhesion of the membranes was most marked on the right temporo-sphenoidal lobe somewhat posterior to its apex. At this point a decided shrinkage of tissue was discovered with depression, the induration involving the uncinate gyrus and parts of the adjacent convolutions. The basal ganglia and motor tracts were normal, and the olfactory nerves were not involved.

Worcester* reports the case of a farmer, aged 30, who had had epilepsy for two years before admission to the hospital. The case presented no special features until January 26, 1878, when after a severe convulsion the man remained in a state of alarming collapse. Radial pulse was almost imperceptible, surface cold, and there appeared danger of immediate dissolution. He rallied somewhat under stimulants, but remained for three days in a stupid condition unable to be long out of bed. Shortly after the attack slight innervation of the right side of the face was observed, but only when the muscles were called into action as in talking and smiling. On February 11th, he regained his ordinary mental condition. No paralysis was discovered except as above mentioned, and no impairment of sensibility except a transient numbness of the hand at times. For several days hallucinations of smell—at first constant, afterwards transitory, were present. Once he imagined the room was full of smoke. He fancied at times there was an odor like the vapor of alcohol passing quickly. He thought this took the place of a convulsion. No test was made of his sense of smell. No marked changes occurred until his death on February 28th, after a series of tonic convulsions, with marked opisthotonos, affecting chiefly the muscles of the back.

The autopsy revealed, on inspection of the inferior surface of the brain, a small red spot of softening at the most prominent point of the left gyrus uncinatus. The brain was not opened until it had been hardened in alcohol. A focus of softening existed in the white matter of the anterior part of the left temporal lobe, extending to the surface, externally, and internally involving the pes hippocampi in the floor of the descending cornu of the lateral ventricle. The portion of the hippocampus major not discolored, was swollen and softened. A very small focus of softening, without discoloration, about the size of a large pea, was found in the white matter of the frontal lobe on the same side. No other gross lesions were discovered, but the perivascular spaces were very generally dilated, so as to give thin sections of the brain a worm-eaten appearance.

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* American Journal of Insanity, for July, 1887.

Gustatory Localization.

Our knowledge of a cerebral centre for taste is even more unsatisfactory and undecided than that for an olfactory centre. Morphology, anatomy, physiology and pathology combine to indicate that this centre is probably situated close to and in the same lobe of the brain as that for smell. The experiments of Ferrier seemed to show that affections of both taste and smell were evidently connected with lesions of the hippocampal lobule and its neighborhood. "It was noted in connection with electrical irritation of the lower extremity of the temporo-sphenoidal convolutions in the monkey, and of the same region in the brain of a cat, that the movements of the lips, tongue, cheek-pouches and jaws were occasionally induced—phenomena which might be regarded as indications of the excitation of gustatory sensation. This interpretation receives support from the above described results of destructive lesions; and we have, therefore, reasonable grounds for concluding that the gustatory centres are situated at the lower extremity of the temporo-sphenoidal lobes, in close connection with those of smell. This would enable us to explain the occasional occurrence in man of anosmia and ageusia as the result of severe blows on the head, especially the vertex. A blow in this region causes counter-stroke of the base of the brain, particularly in the region of the olfactory centres.''

Dr. James Anderson* has recorded a case of epilepsy in which, from symptoms, ocular and cerebral, detailed in his report, he correctly predicated tumor and its position. The patient's dreamy state was associated with a rough, bitter sensation in his mouth. It is the only case published, according to Jackson, in which a necropsy has been had revealing any local morbid changes in a case of the variety of epilepsy mentioned. Dr. Anderson refers to a case, closely like that of his own patient, recorded by Mr. Nettleship. In the report of this case, however, the dreamy state was not mentioned; there was a crude sensation warning in the patient's fits—a sudden feeling of suffocation in the nose and mouth.

As our special subject is the practical relations of cerebral localization, I cannot forbear to recall here the advice of Hughlings Jackson† on the great practical importance of the close study of epileptic seizures. These remarks are made in connection with the discussion of the different varieties of aura—crude warnings of smell and taste, intellectual aura of the dreamy state, temporary word-blindness or word-deafness, noises, flashes of light, hallucinations, etc. No better neurological work, Jackson holds, can be done than the precise investigations of epileptic paroxysms. The efforts should be to describe *all* that occurs in the paroxysms. Epilepsies are as numerous as are paroxyms beginning with different warnings. The warning is the first event from or during the onset of the epileptic discharge ; it is the clue to the seat of the discharging lesion. Using the term suggested by Seguin, I might interpolate here that it is the sensory "signal symptom." The discharging lesions have as many different seats as there are different warnings of the paroxysms.

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* Brain, October, 1886. Quoted by Hughlings Jackson in Brain, July, 1888.

† Brain, July, 1888.

"Before we can make good generalizations," says Jackson, "we must carefully analyze. To group together as 'visual warnings' color projections, apparent alterations in the distance of external objects and 'dreamy states' with definite scenes, is generalizing without previous analysis, and is an attempt to organize confusion ; they are exceedingly different things. He who is faithfully analyzing many different cases of epilepsy is doing far more than studying epilepsy. The highest centres ('organ of mind'), those concerned in such fits, represent all, literally all, parts of the body sensorily and motorily, in most complex ways, in most intricate complications, etc. A careful study of many varieties of epileptic fits is one way of analyzing this kind of representation by the 'organ of mind.' Again, it is not, I think, an extravagant supposition that there are, after slight epileptic fits of different kinds, many temporary morbid affections resembling those persistent ones produced by destructive lesions of different parts of the cortex. To illustrate for a moment by epileptiform seizures ; there is temporary aphasia after some fits beginning in the face or hand (more 'elaborate' utterances, I think, when the exact starting point is in the ulnar fingers) ; this is the analogue of aphasia from a destructive lesion (softening, etc.). To return to epilepsy. There is, I am convinced, in, or after, certain paroxyms of epilepsy temporary 'word-blindness ;' certainly in one patient of mine who had a 'warning' by noise. I could not make out that this patient was at the same time 'word-deaf,' but thought his temporary deafness was ordinary deafness. Still there may have been word-deafness. In another patient who called his attacks 'losses of understanding,' there was clearly both 'word-deafness' and 'word-blindness,' with retention of ordinary sight and hearing ; this patient's attack used to begin with a warning noise, but he has recently had his 'losses of understanding' without that warning."

Jackson holds that there is some local disease in every epilepsy, some pathological process productive of high instability.

His views on the arterio-cortical pathology of some varieties of epilepsy or epileptiform seizures are of great importance to those who are concerned not only in locating the site of a discharging lesion, but also in deciding whether such lesion shall be removed by operation. Sometimes, in the cases already operated on, even when the most careful, and doubtless accurate, localization has been made no gross lesion has been discovered, and yet even in these cases a true gross lesion may have been present—if the plugging of arterioles can be regarded as a gross lesion. Jackson believes that most cases of epilepsy proper are due to the plugging of arterioles. His views upon this question are full of suggestive value. "Centres of taste and smell," he says, "lie, according to Ferrier's localization, in the region of the posterior cerebral artery, whilst, still according to his localization, the centres for hearing and part of the centre for sight (angular gyrus) lie in the region of the middle cerebral. Hence, if arterial plugging be the pathology, it may be that we have different varieties of epilepsy proper, according as arterioles are plugged in different vascular regions. The variety of epilepsy I am remarking upon in the text may be owing to morbid changes in the district of the posterior cerebral. But tumors would grow regardless of vascular regions. I suggest that cases of epilepsy with mixed warning (of smell or taste along with the warnings of color) are more likely to be owing to tumor or other gross organic disease."

Handicapped by the embarrassing proportions of my subject, I have imperfectly presented it for consideration ; but trust that my remarks may open lines of discussion to those here present far better fitted than I to enter the lists in such a debate. These practical discoveries in cerebral localization, with the achievements of antiseptic surgery, constitute the grandest triumphs that adorn the history of our noble science and art of medicine.

SURGERY OF THE BRAIN,

BASED ON THE PRINCIPLES OF CEREBRAL LOCALIZATION.

BY ROSWELL PARK, A. M., M. D.,

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The purposes of this discussion and the division of labor between the essayists of the evening have made it necessary that the following remarks should be confined, as strictly as circumstances may permit, to a consideration of the essentially surgical aspects of the general topic of cerebral localization. To this end I prefer to restrict myself in the main to the surgery of cerebral abscess and to that of intracranial tumor. These are mainly chronic lesions, whose symptoms and signs are to be recognized by the principles already so ably rehearsed by Professor Mills. Indeed, I wish to be excused from considering, except in a casual way, operations for relief of recent hæmorrhage, a surgical field in which numerous brilliant results have been of late obtained, as well as those for epilepsy of traumatic origin, except so far as they are caused by abscesses or tumor, and those in which operation is indicated by a study of the subjective rather than of the objective features ; furthermore, I must also omit all immediate operations for gunshot or penetrating wounds of the cranium, unless they, too, come under the proper category.

Operations are undertaken upon the skull, as they are upon the abdomen, either for exploratory purposes or for relief of a recognized lesion. There is a rapidly growing tendency in favor of exploratory operations in each locality, and, as our technique improves, our confidence in their efficiency and safety becomes strengthened. There was a time when laparotomy for diagnosis was considered quite unjustifiable ; now it is often our duty to perform it. There was a time when the operation of trephining had a mortality rate considerably over 40 per cent.; now in proper hands it has fallen below 3 per cent. Surely many others can say, as can the writer, that they have never lost a patient as the result of this operation. This means really a great deal. Indeed, it is easily susceptible of demonstration that exploratory trephining is the safer of the two. Patients have died immediately after the puncture of the liver or the lung by the aspirating needle, but after similar puncture of the brain perhaps never.* These and other considerations induce one, then, by precept as by practice, to encourage in every legitimate way the early resort to exploratory trephining.

In the preparation of that which follows, the writer has not hesitated to avail himself of the labors and studies of others, and freely acknowledges his indebtedness to the work of Dr. Ferrier, as well as to the writings of those masters of cerebral surgery, Professors Bergmann, Macewen, and Horsley, and indeed to every essay upon the subject which he could utilize.

Cerebral Topographical Anatomy.

Here, as elsewhere, our surgical procedures must be guided by accurate anatomical data, and consequently, following the natural order, we must first consider so much of the regional and surgical anatomy of the cranium as concerns present purposes. In other words, we may properly look to the neurologist to make the diagnosis, but with equal propriety he may expect from us the ability to find the lesion. Not much less astonishing than the discovery of the planet Neptune at the spot determined by the computations of Le Verrier was the first discovery of a cerebral lesion at exactly the point indicated by a careful study of somatic disturbances; both were wonderful examples of inductive reasoning.

The areas which most concern the surgeon in this kind of work are those which cluster along the fissure of Rolando, and the proper determination of the locality of this fissure is to the surgeon what the long base-line is to the geodetic surveyor. Various rules have been laid down by which the location of this fissure may be determined. Without considering all of them, there are two or three of which it is worth while briefly to speak. First, it is necessary to accurately mark out two or three prominences about the skull as points of departure: the root of the nose, known in this sense as the *glabella;* the external occipital protuberance, known also as the *inion;* the point at the vertex of the skull, half way between these two prominences, the *bregma:* the external angle of the orbit, the tip of the mastoid process, the lower border of the alveolar process of the upper jaw—these are all landmarks of importance in one or the other of the methods referred to. Before endeavoring to make out any of the deeper fissures, by external aids, the scalp should have been shaved. The fissure of Rolando has its upper end about five centimetres back of the bregma, but it does not run quite up to the middle line; its lower end lies about half a centimetre behind the auriculo-bregmatic line and a little above an imaginary horizontal line, parallel to the alveolar-condyloid line, projected backward from the superciliary ridge; thus the lower end of the Rolandic fissure will be found about six centimetres above and a little behind the external auditory canal—in other words, its lower end is about an inch behind the bifurcation of the fissure of Sylvius.

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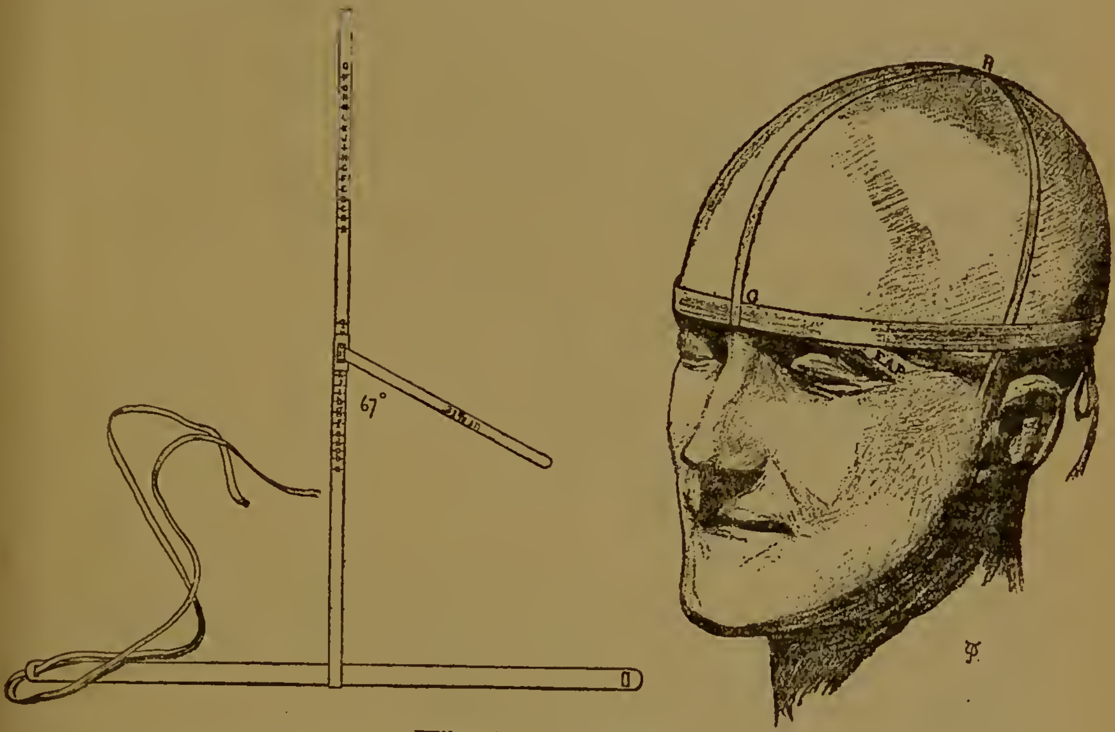
* Since this was written the writer has seen Weir's recently published statement ("Am. Jour. of the Med. Sci.," September, 1888, p. 229) that he has twice seen death follow the introduction of needles into the brain, though to what depth he does not state, nor does he give the size of the needles. (*Vide* below.)



Wilson's Cyrtometer.*

Mr. Hare,† of Edinburg, has shown that the distance of the upper end of the fissure of Rolando is fifty-five and seven-tenths per cent. of the total distance from the glabella to the inion; also that the angle formed by the fissure with the middle line of the skull is sixty-seven degrees. The fissure itself extends about three inches and three-fourths along this line, running from above downward and forward.

At the suggestion of Professor Chiene, Dr. Wilson constructed a scale for localizing fissures according to these data, and which is known as Wilson's *cyrtometer;* a home-made instrument of this kind

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* Described fully in Hare's paper, *q. v.*

† Lancet, March 3, 1888, page 408.

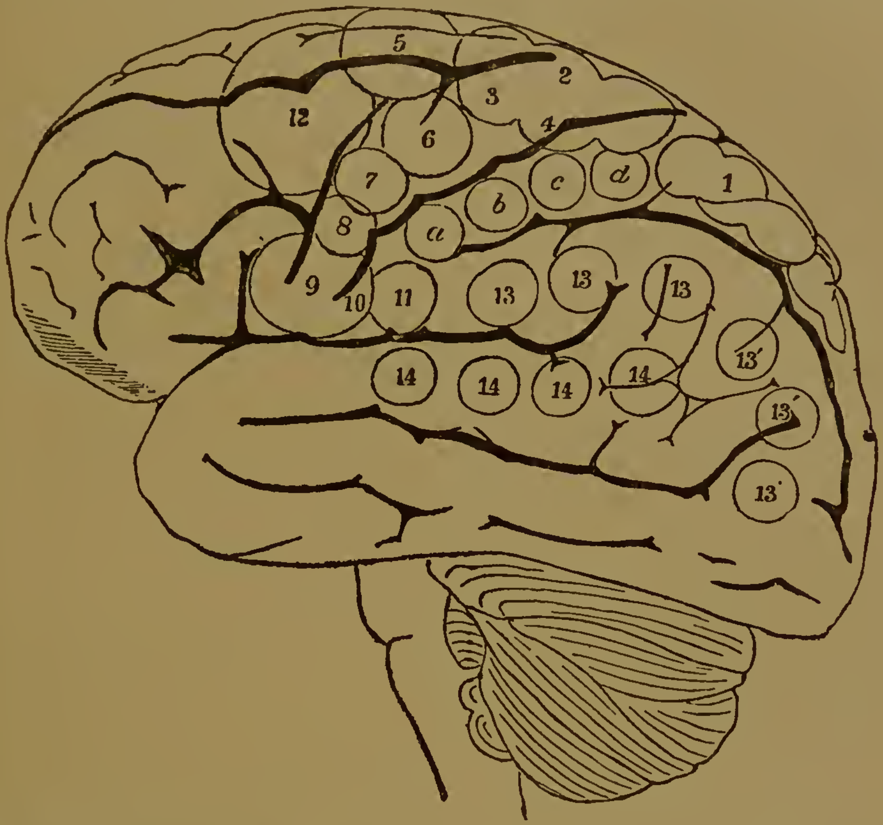
I show you here. One strip passes coronally around the forehead, being fitted over the glabella and external angular process; another strip, at right angles, passes backward from the glabella to the inion. This strip is marked with two scales of letters, and these are located at points accurately marked out, according to the proportion of fifty-five and seven-tenths to one hundred. Should the distance of the inion from the glabella be found to be at a point marked with a capital *C*, the sliding scale on the instrument is put at a corresponding point marked with a small *c;* from this a projecting arm, fixed at an angle of sixty-seven degrees, will be easily bent down, directly over the Rolandic fissure, and with an aniline pencil this may be traced on the surface of the shaved scalp. Accurately speaking, the fissure of Rolando is not a perfectly straight line, inasmuch as it forms a slight curvature opposite the lower end of the intraparietal sulcus, its lower half being directed a little more vertically; nevertheless, the line thus marked out will be sufficiently accurate for surgical purposes.

The bifurcation of the fissure of Sylvius corresponds to a point an inch and a quarter behind and a quarter of an inch above the level of the external angular process of the frontal bone.

The fissure of Sylvius divides into a short anterior and long posterior branch; it commences an inch back of the external angular process, along a line drawn from this process to the occipital protuberance; from this point a straight line to the center of the parietal eminence marks with considerable accuracy the course of the posterior limb of this fissure.

The H-shaped junction of the parietal, the great wing of the sphenoid, the frontal, and the squamous bones was termed the *pterion* by Broca. The point of division of the fissure of Sylvius is just underneath the pterion. The line of the posterior branch has just been indicated; the anterior branch runs upward and forward almost underneath the line of the sphenoido-squamous suture. This anterior branch is important; it is the anterior boundary of the so-called motor region, while the posterior branch bounds the same area inferiorly. The precentral or vertical sulcus, which is not a fissure is of importance, because it divides two convolutions of very different function, and because on each side of it are ranged convolutions in which exist the most extensive variety of motor functions. It runs parallel with and just behind the coronal suture, passing upward and slightly backward, reaching about to the center of the fissure of Rolando, and there bending forward. The inferior frontal sulcus is about opposite the temporal ridge, where it crosses the coronal suture at the point termed by Broca the *stephanion;* or, to be a little more accurate, this point may be termed the lower stephanion, while the upper is at the point where the superior temporal ridge crosses this same coronal suture.

Behind the fissure of Rolando we meet with the intra-parietal sulcus which is the posterior boundary of the motor area ; its commencement



Side view of the human brain, showing location of motor centers. (By Ferrier.)

1. Center for opposite leg and foot. 2, 3, 4. Centers for movements of arms and legs such as are concerned in climbing, swimming, etc. 5. Center for forward extension of arm and hand. 6. Center for supinating of hand and flexion of forearm. 7, 8. Centers respectively for elevation and depression of mouth. 9, 10. Centers for articulatory motions of lips and tongue. 11. Center for platysma and retraction of angle of mouth. 12, Center for lateral motion of head and eyes. *a*, *b*, *c*, *d*. Centers for hand and wrist.

Centers 2, 3, 4, 6, 7, 8 and 9 are in the ascending frontal convolution. Center 5 involves the posterior end of the first; 12, the posterior end of the second; and 9, the posterior end of the third frontal convolution. Center 1 involves the posterior parietal lobule, and 11, *a*, *b*, *c*, *d*, are on the ascending parietal convolution. Centers 13 and 13′ (Ferrier's visual centers) are on the supra-marginal convolution, angular gyrus and occipital lobe. Centers 14 (Ferrier's auditory centers) are on the superior temporo-sphenoidal convolution. (Bramwell.)

is opposite the slight knee-like bend alluded to in the fissure of Rolando ; it passes upward and away from this fissure, and thus forms the ascending parietal convolution ; it runs directly backward, and finally nearly parallel to the longitudinal fissure, passing around the outer end of the parieto-occipital fissure which is at the apex of the motor region.

As Amidon* has shown, the first or superior frontal convolution commences about two centimetres and a half behind the bregma and passes forward nearer the median line toward the orbit; the second frontal occupies a similar but more anterior and lateral position; while the third frontal lies wholly in front of the auriculo-bregmatic line, on a plane five centimetres above the external auditory meatus; its folded part is about two centimetres and a half in front of this line, or about two centimetres behind the external angular process of the frontal bone. The ascending frontal convolution is in front of the fissure of Rolando, the ascending parietal back of it, while the fissure of Sylvius and its posterior division separate the ascending parietal above from the first tempero-sphenoidal convolution beneath. The more exact localization of motor areas can be seen at a glance from the accompanying diagrams, while, for a more accurate description of their exact location, I would refer to the paper of Mr. Horsley in the "American Journal of the Medical Sciences" for April, 1887, page 342; Dr. Roberts's excellent monograph on the "Operative Surgery of the Brain" (Philadelphia, 1885); to a paper by Mr. Hare in the "Lancet" for March 3, 1888, page 407, and to the various monographs and treatises on diseases of the brain which need not be mentioned in detail.

In this connection it might be stated that lesions of the dura over these motor areas are by no means always to be distinguished from the lesions of the cortex beneath; and it is a well-established fact in surgical pathology that various disturbances of the dura can call forth symptoms of profound severity. The researches of Duret "On the Rôle of the Dura Mater and its Nerves in Cerebral Irritation" have shed a great deal of light on the functions of this membrane. In this respect Duret shows that the dura mater contains an abundance of sensory nerves which are extremely excitable, these nervous filaments being supplied from the fifth pair. It is known that irritation of the branches of the fifth often produces reflex spasms which may radiate down the cord, mainly, but not always, on the same side; or which may produce contractures of the muscles of organic life, pain, hyperæsthesia, neuralgias, and many other reflex sensory or motor phenomena.

These symptoms tend to diffuse and invade neighboring groups of muscles. They have never the localization, the measured and purposed character, of contractions which belong to lesions of the cortex. They frequently become transformed into permanent contractures. The reflex vaso-motor disturbances due to irritation of the nerves of the dura mater consist in spasms, or congestive paralyses of the cerebral and ocular vessels, either on the same or the opposite side. These facts are important to pathologists, as they show the great influence of irritation of the nerves of the dura mater on cerebral vascular conditions and on the organs of sense, and shed light on the causation of secondary effects in cerebral traumatism—that is, on the congestions and inflammations of the cerebral membranes. Destructive lesions cause local anæsthesia of the dura mater.

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* Medical News, June 21, 1884.

I have taken this statement *in extenso* from Duret because of its importance. These observations on lesions of the dura, coupled with those confined to the brain proper, lead me to simply make this remark in addition to what has already been said : It is enough for the surgeon that a lesion of some kind can be located with reasonable accuracy. It matters not whether this is an old irritative lesion of the dura, an acute suppurative process anywhere between the bone and the brain, or an abscess or a tumor in the brain itself. The indication for exploration is just as strong, and it is the surgeon's bounden duty to penetrate the bony roof of the brain and be prepared to do anything which may appear to be indicated, just as in abdominal surgery one begins an operation as an exploration, being prepared to meet the indication upon anything which may be discovered within.

While the cerebellum is, in the future, to be by no means exempt from surgical invasion, we are, nevertheless, not here bewildered by such a wealth of topographical boundaries and divisions. It lies entirely beneath the tentorium, which divides to form the lateral sinus. This sinus follows a line nearly corresponding to the superior curved line of external occipital surface, but a little below it. It would be best in operating to allow, at all events at first, half an inch, and even then, to perforate the bone with caution. It must also be remembered that the torcular Herophili is seldom exactly centrally situated—most commonly a little to the left—and that the region three-quarters of an inch on either side of the middle line had better be avoided, at least for the first perforation.

Other facts to be borne in mind are that children and the aged have no diploë ; that the crania of the aged may be extremely thin ; that the frontal sinus is not to be ignored in operating in its neighborhood ; that the superior longitudinal sinus is beneath the middle line of the vault ; and that the middle meningeal artery lies about an inch and a quarter back of the external angle of the orbit, and is sometimes almost buried in a bony channel.

When and Where can one Trephine with Safety and Where should one avoid Perforation of the Bone?

Probably the safest rule to follow is that the first application of the trephine should be over those well-known areas of the skull which do not overlie large vascular channels, as, for instance, those points where one may wound the middle meningeal artery, the superior longitudinal sinus, the lateral sinus, the occipital sinus, and so forth; but, after an opening has been made at points free from this danger, it may be extended in any direction, to any required extent, with a feeling of security, inasmuch as the larger the opening, the better our ability to cope with hæmorrhage, no matter what its source. Hæmorrhage from the middle meningeal artery can, under these circumstances, be easily arrested. Our greatest hesitation would be with regard to opening one of the sinuses of the skull. Two dangers attend such an accident—one of a fatal air embolism, as has happened to Volkmann in the removal of a sarcoma of the vertex of the skull; the other, that of profuse hæmorrhage. The former danger is almost a theoretical one, since operations on the brain proper are not nearly so likely to lead to this accident as lesions involving the bony skull itself. The latter is one which experience has taught is by no means fatal; for, should hæmorrhage thus occur from a sinus, the sinus itself may be plugged, or its wound may be closed with a fine needle and suture. Indeed, Bergmann entirely removed a part of the superior longitudinal sinus in one of his cases. The researches of Schellmann have shown that the integrity of one sinus at least may be destroyed without any serious effect upon the brain itself; though, theoretically, one must perhaps hold to the opinion that the liability to œdema of the brain will thereby be increased.

Parts of the Brain which may be considered as Proper Fields for Operation.

A variety of cases, some slight, some terribly severe in their destructive effects, have shown that, after all, there is but a comparatively small portion of the brain which can not be considered, in some sense, superfluous. We find that, after destruction of one part, another part, by a species of substitution, takes up its action; and we find from experiments on animals that large portions of more than one hemisphere may be removed without serious consequences. We may reasonably say that a tumor or an abscess in the brain, whose boundaries are continually enlarging, and which is consequently causing an increasing amount of destruction, is doing more harm than can be done by the surgeon's knife which shall judiciously remove it, and thus take away the possibilities of harm caused by such a lesion. We may say, almost without question, that any part of the hemispheres is amenable to surgical attack, and at least a large portion of the cerebellum; only the basal ganglia, the pons, and the medulla can now be considered sacred, partly on account of their inaccessibility, partly on account of their primary functions. Further and more extensive experience may in some slight degree modify this statement, but it seems as though we were justified in making it with a reasonable degree of assurance. If we have any doubts in the matter at all, they are with reference to the cerebellum. The cases of Hulke, Horsley, Weir, Suckling, and Hahn, have shown that this part of the brain is amenable to surgery, but we are not sure as to just what extent. The case of Detmold, elsewhere alluded to, showed years ago how deep collections of pus might be evacuated; and a case recently reported by Dr. Blake, of Baltimore, in the "Philadelphia Medical Times," July 2, 1888, also the celebrated case of which the specimen is now in Harvard Museum, or that reported in the "Medical Press of Western New York" for August, 1888, along with many others, will show that extensive or deep wounds are not necessarily fatal.

Cerebral and Cerebellar Abscess.

In his recent masterly paper, Bergmann,* in considering this topic, lays stress on the fact that abscess of the brain in adults has but one result—death; and that the surgeon's knife offers the only relief. The greatest difficulty lies in exactly diagnosticating the nature and locality of the trouble. So far as we know, there is no such thing as idiopathic abscess of the brain; it is always a sequel either of some external wound of the head or of some extension from diseased surrounding bone. The only exceptions to this statement are to be found in the case of pyæmic or tuberculous abscesses. Multiple abscesses are *almost* invariably metastatic, and consequently imply pyæmic process, though a few exceptions have been reported.

Bergmann assigns a distinct place to acute cortical abscesses which form just underneath a point of fracture or of injury, which are to be distinguished by disturbance of healing, the altered aspect of the wound, or the escape of pus; or, if these be not noted in time, probably later by the symptoms of an acute meningitis. Nevertheless, it is not always easy to distinguish between such an abscess and a suppurative meningitis ; either may cause paralytic phenomena. The latter is perhaps more betokened by the changes of the incompletely healed wound than by pathognomonic symptoms. A leptomeningitis may develop with almost lightning-like rapidity, whereas time is required for the formation of an abscess. We scarcely expect an abscess to give characteristic signs before the second week. If slower than this, ample time has been given for such adhesions to form as may constitute an effectual barrier to the advance of pus. Under such circumstances we have a localized collection of pus rather than a diffuse meningitis—one which can be easily opened and drained.

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* Archiv. f. klin. Chir., xxxvi., 1888.

There is a notable difference between these superficial abscesses which develop in a few days, usually with symptoms that remind one constantly of a leptomeningitis acuta, and the formation of those deeper collections of pus in the brain which may lie dormant for weeks, months, or even years. The former are the direct result of surface lesions. The latter are not to be thus explained. Only exceptionally do we see evidences of extensive external lesions. Even violent injuries, such as cause concussion, are not often followed by them. They correspond to the abscesses which form in bone—*e. g.*, the femur—and are the result of intermittent processes. Between the pus and the cortical surface lies apparently healthy brain-matter ; whether the exciting impetus is transmitted along the lymph-vessels or the blood channels is not now clearly made out.

It is the peculiarity of cortical abscesses to follow more or less superficial wounds ; the deep ones seldom if ever have such a history. The latter more commonly are associated with foreign bodies or particles of bone driven deeply in. Protracted external suppuration does not seem to predispose toward them of itself, unless followed by caries or necrosis.

Another and non-traumatic class of abscesses is that connected with disease of the middle ear, or non-traumatic suppuration in other parts of the bony envelope of the brain. Nearly half of the entire number of cerebral abscesses have this origin. It is only chronic otitis media suppurativa which leads to this result. Acute brain symptoms have followed acute ear trouble, but never a brain abscess. The method of their extension is too well known to need description here.

The position of abscesses connected with middle-ear disease is of surgical interest. Almost without exception they are found either in the temporal lobe or in the cerebellar hemisphere ; in children most commonly in the former ; in adults in the latter.

One of the most uncertain features about all of these deep abscesses is the date of their origin. Suppurative processes in other parts of the bony skull have a similar influence in determining deep brain abscess. Perforating tubercular disease of the bone at any point may lead to abscess beneath; so may caries of the ethmoid or frontal, or ulcerative disease in the nose.

The symptoms of deep brain abscesses may be divided into three groups, according to their cause:

1. Those which are inseparable from indications of suppuration. Such are those disturbances which may follow any deep-seated foreign mass.

2. Symptoms of increased intra-cranial pressure and disturbed relations.

3. Special symptoms by which the locality of the disturbance may be ascertained (localization).

(1) Of all these symptoms and signs, fever is the most significant. This may be very irregular with long periods of intermission. This is of less value when there is coincident suppurative disease of the middle ear, since it may thus be accounted for.

(2) The most significant symptom of increased pressure is headache—a persistent headache, varying in degree, always worse when the patient's temperature is raised. Everything which can increase intracranial blood-pressure—use of alcohol, too low position of head, etc.—increases the pain. In middle-ear cases the headache is more fixed and localized. It is increased by percussion over the affected area.

Other pressure symptoms are less frequent in abscess cases and more variable. Marked alterations of pulse and respiration rate, a pulse even as low as 30, and Cheyne-Stokes respiration with coma, have been noted. These alarming symptoms may shortly subside, however, and such changes for the better and worse are much more common in abscess than in brain tumor. Choked disc is also less frequent in cases of abscess.

(3) Localization symptoms are often conspicuous when the abscess is in the motor area, the reverse when in the frontal, temporal, or occipital lobes. The local disturbances may be easily confused with those caused by simple degenerative processes (softening), such as in all probability are actually taking place around the abscess. In case the abscess subsides into inactivity and is followed by cessation and contraction, the local symptoms may much improve. The pus collecting in the depths of the hemispheres may only separate the motor impulse conducting paths, without materially affecting their integrity. So long as the gray matter is undestroyed, the collection of pus may assume large dimensions, even involve almost an entire hemisphere, and still no intense motor disturbance appear. But the nearer it

approaches the cortex, and the more destruction it causes there, the more we may expect motor disturbances.

Like others, Bergmann lays considerable stress on local elevation of temperature over the abscess. General experience shows this to be a sign of great value when met with, but one the absence of which need by no means negative a diagnosis if made on other rational grounds.

The same writer also maintains that there is less probability of early recognition of abscess in the frontal lobes, since it is well known that these may be almost totally destroyed without symptoms. But the larger it grows and the further its encroachments extend posteriorly, the more likely are we to get disturbances of speech, or paralytic features about the face or eyes. Bergmann says facial paralysis implies that the abscess in the frontal lobe—if such there be—is large.

Certain peculiar features are alleged to pertain to abscess in the *temporal region.* Thus Wernicke has stated that there is a peculiar disturbance of speech which points especially to this lobe as the locality of the disturbance. This is the confusion of correct with incorrect or fictitious ("*erdichteten*") words; it is a species of aphasia implying interruption in coördination which results from trouble at this point.

Abscesses in the cerebellum for the most part go unrecognized. Frequent and severe attacks of vertigo, along with headache, loss of sensibility and of motion, are indications not usually lacking. According to Nothnagel, a staggering or swaying gait would imply lesion of the vermiform portion. But a collection of pus above the tentorium may produce similar disturbance in the underlying cerebellum by mere pressure.

In a paper on "Surgical Interference in Cerebral Abscesses," by Dr. Nancrede, of Philadelphia,* some valuable hints concerning the diagnosis of cerebral abscesses are given. He believes that such abscesses are accompanied in most cases by a subnormal temperature. Where a high local temperature is noted, either the pus is from a localized inflammation of the arachnoid, limited by adhesions, or else there is a meningitis in addition to the abscess. If originating from ear disease, where the abscess is secondary, the temperature is usually above normal, although not invariably so. When the motor area is involved, diagnosis is easy; where the motor area is not involved or has not been primarily affected nor injured, chance only can lead to a determination as to the location of the pus. His paper is additionally valuable on account of the cases to which it calls attention.

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* Transactions of the American Surgical Association, vol. ii., p. 85.

In the Edinburgh Med. Journal,* McBride and Miller have given some valuable hints as to the diagnosis and treatment of cerebral abscess due to disease in the ear. When the auditory nerve is intact the brain abscess is, in all probability, located in the neighborhood of the tympanum. In this case one should trephine above and a little in front of the external meatus. It would be well to so plan the external incision that one can also attack the mastoid process. When the auditory nerve is involved, the pus will usually be found beneath the tentorium cerebelli. In case of thrombosis of the lateral sinus, one had better abstain from operation. If, instead of an abscess, one comes down upon a diffuse meningitis, the operation will still be serious. McBride calls attention to the fact that in suppuration of the mastoid cells there will usually be pain on pressure over the process. In cases of chronic suppurative disease in the ear, it is better not to wait too long before opening the mastoid, if there is any reason to suspect the presence of pus.

In the treatment of mastoid disease it occasionally happens that opening the mastoid and detecting pus the surgeon comes to a halt because he considers that he has done enough in the absence of clear indication to the contrary. It may happen that subsequently cerebral symptoms supervene which point toward an abscess in the brain ; in such a case it will be proper to enlarge the original mastoid perforation to the necessary extent, to expose the dura, and to explore with a hollow needle. If pus is found, the abscess is treated as usual ; if no pus is found, no harm will have been done.

It has been a number of times shown that the temporo-sphenoidal region of the brain better tolerates surgical interference than almost any other part of it. If it should be generally taught that, anatomically and surgically, no good reasons exist why opening of the dura and draining of the middle fossæ should not be practiced in cases of suppurative meningitis, we should not have the sad fact to contemplate that so many of the cases of cerebral abscess due to ear disease die unrelieved by mastoid operation. If cerebral abscess can be excluded in favor of an abscess in the cerebellum, no hesitation should be felt in trephining through the skull below the tentorium. Mr. Barker has laid down an excellent rule in such cases—namely, to explore the opening of the mastoid vein at once ; if purulent softening has extended backward toward the cerebellum from the ear, some of the discharge will be found oozing from this opening. Not enough attention has been paid to his observations.

In the general diagnosis of cerebral abscesses it is necessary to re-

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† May, 1887, p. 896, and June, p. 995.

member that there is usually a latent period, devoid of all brain symptoms, which may continue for an indefinite time, from a few days to several years. The stage of active symptoms is usually ushered in by more or less headache and slight rise in temperature; local or motor symptoms can be expected only when the abscess is in the motor area of the brain. With regard to the operative procedure, it is worth while to remember that Renz published in 1867 a case in which a traumatic cerebral abscess was reopened on account of symptoms of compression. In this case Renz practiced regularly a series of aspirations, emptying the abscess cavity through a small hollow needle twice a day for six weeks. Aspirations were discontinued during the sixth week, but had to be resumed five days later, and were continued six weeks longer. The patient recovered in half a year, and has since remained well. This is the first case on record of systematic and intentional aspiration of cerebral abscess. At the present day no one would think of practicing this method, but would make continuous drainage. When we remember that abscesses large enough to cause cerebral symptoms usually have a cavity at least large enough to find and empty, we should be less unwilling to trephine and explore when we suspect the presence of one.

In 1855 Detmold opened the lateral ventricle with a knife and evacuated a quantity of pus, his patient dying later. In this instance he set an example of free evacuation of pus from the depths of the brain, which surgeons were uniformly slow in following.*

The question whether it is best to wash out an abscess in the brain after it has been freely opened is one not yet positively answered, authorities disagreeing; however, it would seem as clearly indicated to thus cleanse a pus cavity in the brain as anywhere else, especially so where the pus is fœtid as it is in many of these cases. Fenger has suggested that possibly œdema or encephalitis in the neighboring portions, which are more dangerous than the abscess itself, may be by this measure prevented.

Operation for Abscess of the Brain.

Directions have been given by so many writers as to how to proceed in cases of suspected or certain abscess of the brain that it hardly seems necessary to repeat them here. The reader interested in securing explicit directions is referred to the papers of Fenger and Lee,* Nancrede† and Weir.‡ These operations are to a considerable extent satisfactory, since the lesions can be diagnosticated with some certainty. The indication is not, under all circumstances, to operate on every case of abscess, or on those of every part of the brain; we have probably yet to learn, so far as clinical experience can teach us, what to attack and what to leave alone.

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* Dr. Detmold's case was reported in "The American Journal of the Medical Sciences," 1850. The brain was exposed on account of necrosis; as exposed, it was felt to be fluctuating; the opening was in the left frontal region, twelve centimetres square. Some four ounces of pus were evacuated, and the patient immediately opened his eyes and answered questions. The patient died over a month later, and, on autopsy, pus was found in both ventricles.

Traumatic brain abscesses have long been known, but until recently operators have satisfied themselves with incising the dura and doing nothing more. Quesnay and La Peyronie expressed a wish to explore deeper, but yielded to the conservatism of their day and did not. Dupuytren was the first to put a bistoury into the brain and thereby evacuate pus. Unfortunately, the death of his patient for a long time deterred others. Perhaps the next one to imitate him was Detmold. With the introduction of aspiration methods the hollow needle came naturally to be suggested for brain exploration. The dangers of this procedure are certainly small; indeed, the more certain the diagnosis of abscess, the less the danger. And yet less than five years ago, when the writer ventured to read a paper on this subject and to report cases in which he had resorted to it without harm to the patients, more than one friend whose judgment he valued advised him not to publish it lest he bring discredit on method and writer alike.

The most painstaking investigations which have been made in this direction are those of Spitzka.§ He has made careful search in brains after exploratory puncture had been done. In an autopsy three months after three needle punctures had been made no indication of puncture could be found in dura, pia, nor the surface of the brain. After making thin sections of the region involved, three dark-bluish lines were found extending vertically to the surface. These were found to be minute pencils of coagulated blood. There were no spider cells, nor indications of the slightest inflammatory disturbance, nor did neighboring nerve cells show any change. Several times after injecting foul or irrigating material into the brains of dogs, for experimental work, he failed absolutely to find any track of the needle or trace of its having entered the tissues, even though the foreign material injected through it was found encapsulated.

In one case, however, after thirteen months, the entire channel made by the needle was plainly visible. The obliteration of the needle tracks was most conspicuous in the largest and most vigorous animals. Referring to the depth to which needles may be passed, he advises that they should never be introduced so far as the internal capsule, the contiguous ganglia, nor the lateral ventricles, merely for exploratory purposes, unaided by positive clinical indications of the location of the disease. Certainly the dangers of exploration with a small aspirating needle are slight.

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* Am. Jour. of the Med. Sci., July, 1884, p. 17.

† Med. News, Jan. 28, 1888.

‡ Med. Record, April 9, 1887.

§ Trans. of the Am. Neurological Assn., 1887.

But little more dangerous is an incision into the cortex. Among the hundreds or thousands of experiments on the brains of animals, how little evidence of the harmfulness of this measure can be adduced! Almost invariably no unpleasant effect follows.

Next to the danger of doing anything of this kind, that from hemorrhage has been the greatest in common estimation. But even this has been greatly overestimated. Most of the blood comes from the vessels of the pia rather than from the brain matter proper. The picture of a traumatic apoplexy may be most unpleasant, but is a most improbable one. In the use of the temporary tampon we possess an effectual method of combating this. And if it is the vessels of the pia which particularly give trouble, they may be lifted up from their resting places and secured, or one may follow the suggestions of Fluhrer or Nancrede and leave one or more small *serres-fines* in place for a day or two. We must only remember that the cerebral arteries are all terminal.

It has been shown that the brain resembles the kidney in this respect—*i. e.*, that its proper vessels are excentrically directed and run almost perpendicularly to its surface; consequently, if an incision be made in this same relative direction, but few of these will be wounded. It has also been shown that, while oozing from such a wound may be for the moment rather free, it will readily subside after the insertion for a moment of a tampon or sponge. The danger of hæmorrhage, primary and secondary, will be alluded to again further along.

With regard to brain abscess consequent upon middle-ear disease we have only to add some suggestions as to the best points at which to trephine. According to Bergmann,* the best position for application of the instrument is above and behind the ear. Draw a line from the lower border of the orbit to the middle of the external ear, and continue it backward. Four centimetres back from the external auditory meatus erect a perpendicular to this line, and at a point four to five centimetres above the first, on this second line, the middle temporal lobe will be reached, without danger of injuring the posterior branch of the middle meningeal artery—a danger nearly unavoidable if the trephine be applied just above or a little in front of the ear.

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* *l. c.*, p. 801.

Macewen has proposed to make the first perforation through the squamous bone six centimetres above the ear, and then to follow with a second counter-opening on a level with the floor of the abscess, wherever this may be. Numerous cases are on record where death has resulted from failure to make this second opening (Nancrede), although Bergmann considers such through drainage inadvisable, holding that a single opening is sufficient if drainage is favored by position ; irrigation, even, in his opinion, being at times injurious.

If abscess in the cerebellum is suspected, important information may be gathered by an incision from the mastoid foramen to the mastoid-occipital fissure. If pus appear here, along the vein or under the periosteum, then it is probable that it has worked its way into the posterior fossæ of the skull and determined an abscess in its contents. For, as Mr. Barker * says "if there be inflammation in the posterior aspect of the petrous bone, it can hardly reach the cerebellum without forming a layer of pus under the dura mater of the lateral sinus." Any extensive operative procedure upon the cerebellum means attacking it below the tentorium. An aspirator needle might be passed into the cerebellum through this membrane from above, but any tumor or abscess which it is proposed to radically attack must be reached from below the tentorium. (*Vide* the remarks above on *Topographical Anatomy.*)

Brain Tumors.

The various tumors of the brain are no longer of interest solely to the clinician and the pathologist. Thanks to the researches of these gentlemen, a field of cerebral, and I may add cerebellar, surgery has been opened to us which was a few years ago literally *terra incognita.* Prompted by the brilliant discoveries of Hitzig, Fritsch, Ferrier, and others only less well known, Macewen, Godlee, and Horsley were quick to take practical advantage of their results and to inaugurate a new era in surgical achievements—an epoch, indeed, whose remarkable results have only been surpassed by Mr. Horsley's recent successful removal of a myxoma from the spinal cord, and Macewen's somewhat similar cases.

Indeed, if you will pardon the moment's digression, so astonishing have been the advances of the past twenty years that one finds ample justification in maintaining that, with the sole exception of the science of electricity, nowhere in the whole domain of theoretical or applied science has progress been so rapid or visible results so remarkable as in surgery. So far as operative surgery is concerned, it can now rank as an exact science.

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* British Medical Journal, December 11, 1886, p. 1155.

But little must here be said about brain tumors save in a purely operative sense. Their general features, which most concern the surgeon, have been well summarized in a paper read by Dr. Zenner before the Cincinnati Academy of Medicine, February 1, 1886. The principal features of a brain tumor which produces symptoms are : first, its location ; second, its size ; third, its character ; fourth, rapidity and manner of its growth ; and fifth, extent to which it affects the surrounding brain. The various ways in which a tumor may produce symptoms are : first, by increased pressure ; second, by direct influence on brain tissue. When a tumor is in the cortex, the adjoining brain gradually accommodates itself, to a certain extent, to the increasing pressure ; at the base or in the neighborhood of the nerve trunks such condition is not met with in many cases. When a part of the cortex has been destroyed, another part assumes a certain portion of its function. The symptoms produced by these changes may arise either from loss of function or from irritation. Nerves may be compressed where they pass through the dura, or directly in their course, or by enlarged blood-vessels. Convulsions may occur from tumors in any part of the brain ; optic neuritis is by no means common. The chief localizing symptoms are paralysis of the cranial nerves, hemiplegia, monoplegia, hemianæsthesia, partial spasms, reeling gait, aphasia, and hemiopia. In the frontal lobes, the corpora striata, and the optic thalami, brain tumors are frequently latent. When an individual suffers from constant headache that is not relieved by ordinary methods of treatment, he should be examined for brain tumor. Wernicke has suggested an operative procedure in cases where removal is not to be thought of—namely, tapping the ventricles in order to relieve intra-cranial pressure. This may be of value in rare or unusual cases. Tumors in the posterior fossæ of the skull usually cause a large accumulation of fluid in the ventricles. The distended third ventricle presses downward on the optic chiasm and produces optic-nerve atrophy ; these are the cases in which blindness appears early—in other words, atrophy of these nerves is usually the result of a tumor in the posterior fossæ of the skull, generally in the cerebellum.

Considered in their surgical relations, we may, with Bergmann, divide brain tumors into (*a*) the circumscribed (encapsulated); (*b*) the infiltrating (diffuse), around which, as a rule, there is a zone of softening. The former displace the brain substance, the latter destroy and supplant it. The former may be enucleated, the latter not. In order to remove the latter, one must remove a wide margin of surrounding tissue, as in removal of similar growths in other parts, or he must make total ablation, which is only possible in two places—the frontal and occipital extremities. Obviously these limitations reduce at once the number of cases suitable for operation.

Yet another class of neoplasms deserves at least mention here—*i. e.*, those growing from the interior of the cranium. These by pressure may give rise to meningeal irritation or pressure symptoms, or both. Providing that a reasonably satisfactory diagnosis can be made, it must be indeed an extensive growth from the cranial vault which shall contra-indicate operation. It is not so uncommon an event at present to see large areas of the bony covering of the brain removed for the extirpation of neoplasms involving them or the membranes, and pressing on the brain. Gussenbauer has removed half of the frontal bone with a little of the great wing of the sphenoid and the squamous, recovery following without disturbance of any kind. Macewen has done nearly the same thing. Langenbeck and Bergmann have excised large pieces of the dura, and the latter, as well as Küster, not only has done this, but has removed a portion of the superior longitudinal sinus. No hesitation need then be felt in attacking any such lesion so long as the general condition of the patient may warrant it.

But supposing the case of a tumor in or near the cortex, we are, if possible, to learn yet more about it. It should not be a diffuse growth surrounded by a zone of degenerated tissue, nor should it be too large or extensive. These tumors are not always so constituted that they are easy of recognition even after exposing the brain. Unfortunately, diagnosis as regards one of these features is as difficult as concerning the other. Bergmann says that when amidst slight and late brain symptoms signs of increased intra-cranial pressure quickly develop, the probability is that we have to do with an infiltrating tumor. Tumors growing from the skull can be estimated with perhaps a little more exactitude, although these penetrate a considerable distance, even over motor areas, before they occasion great disturbance.

Considering the uncertainties of diagnosis, some would think it advisable before removing a large area of bone to make an exploratory opening with the trephine, and even an exploratory incision down to the white matter. Such a procedure would be quite in accord with the principles laid down in the beginning of this paper when advising more frequent exploratory operations. No harm is likely to be done by the preliminary operation, and a clear indication to abstain, thus gained, will often be more satisfactory than the uncertainty which must otherwise surround the case.

According to Jastrowitz* one should only undertake to extirpate those tumors which are peripherally situated, and in respect to which it can be determined that they are non-multiple, not too large, not infiltrating, and not located in vital parts. Still, if we are to be confined too strictly to this dictum it will prevent us from removing as large tumors as Durante has already shown us we can extirpate successfully, and it will hinder us from trying to imitate Weir's success in removing an infiltrating tumor with two adjoining secondary growths.

What and how many Brain Tumors are Accessible?

The best answer to this question has been given by Hale White.† He carefully studied the records of one hundred brain tumors found in the dead-house of Guy's from 1872–'84, with particular respect to possibility of operation. According to the records, one brain tumor was found in every fifty-nine autopsies.

Of the 100 studied, 45 were of tuberculous nature, 24 gliomas, 10 sarcomas other than glioma, 2 glio-sarcomas, 5 carcinomas, 4 cysts, 1 lymphoma, 1 myxoma, 5 gummata, 3 undetermined—total, 100.

Bergmann has carefully gone over White's researches, and concludes that all the tuberculous and gummatous neoplasms must be excluded from consideration in an operative sense. Brain tuberculosis is almost impossible of diagnosis and has always occasioned most unfavorable prognosis, but this he hopes modern surgery may make brighter. Nevertheless, as these tuberculous masses consist almost always of caseous material, it would be most difficult to extirpate them from the soft tissue in which they lie imbedded with any such completeness as is indicated. An operation would in such a case be necessarily incomplete, and return would quickly take place, with, in all probability, tuberculous meningitis. In all of White's forty-five tuberculous cases some other organ was affected, usually several others. In only three of them could operation have offered any prospect of success ; but in one of these, with a tuberculous mass on the median side of the left hemisphere, there was tuberculosis also of the peritonæum and Fallopian tube ; in the second, with a nodule near the fissure of Rolando, there was infection of lungs and intestines ; and in the third, with a focus in the left side of the cerebellum, there was similar disease in the mesenteric glands.

Judging from these cases, it is extremely rare that cerebral tubercle will be considered amenable to surgical help, even could it be exactly diagnosticated. Bergmann considers it impossible that the cases reported by Macewen—one as a successful removal of a caseous nodule from the ascending frontal convolution, and the other as a successful evacuation of a tuberculous cyst *—were cases of genuine tuberculosis; in his estimation they were distinctly syphilitic, and should have been treated with antispecific remedies. Thus far the only genuine and undoubted case is the brilliant one of Horsley, who removed a tuberculous mass from the right cortex of a young man of twenty. Brain syphilis is, in Bergmann's opinion, to be treated with drugs rather than by instruments.

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* Deutsche med. Wochenschrift, No. 11, 1888, p. 209.

† Guy's Hosp. Rep., 1886, p. 117.

Of the thirty-six sarcomas included in White's studies, fifteen were diffuse and widely infiltrated, and fourteen were utterly inaccessible. Only in four could operation have effected any good. In one of these the tumor was in the middle line of the cerebellum ; in the second it sprang from the dura and pressed on the cerebellum ; in the third its site was the frontal lobe ; and in the fourth the occipital. Two of the three undetermined tumors were operable ; one lay in the left lobe of the cerebellum, the other, of dural origin, invaded the right hemisphere.

Of the four cysts, two were multiple and one was complicated with a cancer on the neck and was accidentally discovered ; the fourth might have been easily removed, since it lay isolated in the cerebellum. So, too, might the myxoma have been attacked, since it was quite superficial.

In brief, of White's one hundred tumors only nine could have been removed—namely, one tuberculous nodule, four sarcomas, two undetermined tumors, one cyst, and one myxoma. In other words, 9 per cent. could have been attacked, *providing* a fairly accurate diagnosis had been made. *Ante-mortem* diagnosis, however, and anatomical diagnosis are two very different feats. Of the above mentioned nine, five were located in the cerebellum, one in the frontal lobe, and one in the extremity of the occipital. It is very doubtful if these seven could have been recognized accurately enough during life to have justified attack, while the myxoma was impossible of diagnosis. We are then narrowed down to one tumor out of the hundred which was susceptible of both exact localization and extirpation, even when looked at in the light of the acquirements of to-day. This is not a very favorable showing, to be sure, and is to be accepted only for what it is worth. If it has any very striking bearing I should regard it as only another argument in favor of tentative exploration.

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* Lancet, 1885, i., 881, 934.

The Operation for Intra-cranial Tumor.

With regard to the technique of operations on the cranial contents, Mr. Horsley has left but little to be added to the admirable remarks which he has published in the "British Medical Journal," October 9, 1886, page 670, and in the same journal for April 23, 1887, page 863.* To these papers of his the reader and the student of the subject should certainly be referred, and the writer will make no effort to copy his observations in detail. Nevertheless, owing to the extreme importance of the subject and the general interest in it, a brief rehearsal of the most important points in operative technique will not be out of place here.

Preparation of the Patient.—The patient's head should be shaved two or three days before the operation and carefully washed with green soap and ether, or a mixture of ether and turpentine. From that time the vault of the skull should be kept enveloped in a moist antiseptic compress. In this connection it is worth while to add just here that Dr. Keen has called attention to the utility of shaving the scalp in every case of suspected intra-cranial lesion, since in two cases he found scars after shaving which were previously unnoticeable.

Aside from this, the usual preparatory treatment suitable for all severe operations should be adopted. The anæsthetic should be chloroform, unless some peculiar feature about the case makes it unwise. Chloroform is known to have a contracting influence on the vessels of the brain ; hence its efficiency in these cases. Mr. Horsley has suggested and advised hypodermic administration of morphine previous to operation, with a view of also profiting by its effect in contracting the cerebral vessels. Dr. Keen has resorted to ergot for the same purpose. To the writer it would seem that a combination of the two might be preferable to either alone. In case the patient was already so unconscious that no anæsthetic was needed, the hypodermic use of ergot would amply meet the indication. The lesion should be located as accurately as possible by the methods spoken of in another part of this paper. The writer would suggest the driving of a small, disinfected, headless tack through the scalp into the skull over the center of the area previously located. After dissection of the external flap this tack will serve to point out accurately the portion to be first attacked.

Another point in operative technique. In order to prevent hæmorrhage from the scalp during the superficial explorations, an elastic bandage may be tightly tied around the skull for as long a time as may be required. The question might also be raised whether in some very extensive operations of this kind it would not be justifiable to put into practice that which Senn has shown can be successfully done upon dogs—namely, the isolation of the trachea and the application of a rubber bandage back of it around the whole of the neck. By this procedure he found that the most extensive operations could be done upon the brain or skull as bloodlessly as they are now done upon the extremeties.

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* *Vide* also papers by Macewen, "Med. News," Aug. 18, 1888, p. 169, "Brit. Med. Jour.," Aug. 11, 1888; and by Weir, "Am. Jour. of the Med. Sci.," September, 1888, p. 219.

The styptic properties of cocaine solutions have led Keen and others to resort to them as hæmostatics in the brain surgery. Experience must yet show their real value, but they are well worthy of a trial. We are not yet in position to say whether their secondary relaxing effects upon the vessels will lead to any unpleasant disturbance or hæmorrhage. For my own part I have also repeatedly seen benefit from the application of antipyrine solutions on account of its styptic properties. Antipyrine is not only a good hæmostatic, but has some antiseptic properties. It is possible, therefore, that a spray of a one-to-forty antipyrine solution, directed upon the exposed brain tissue, would prove of considerable benefit. In order to test this matter I have anæsthetized animals, and, after extensively uncovering the brain, have cut into it in various directions, and, after causing a free hæmorrhage, have directed upon the part a spray of three-per cent. antipyrine watery solution. Invariably I have seen almost instantaneous evidence of its styptic virtues, and should not hesitate to use it at any time in operating on the human brain.

The old method of beginning the operation was to make crossed incisions. The raising of a semilunar flap, or one of horse-shoe shape, is much superior. This flap should have its apex in such a position that, as the patient lies upon his back, drainage may be made by mere force of gravity. There is an advantage also in raising the periosteum with the flap of the skull. While the Lister carbolic spray is not now often used, still most authorities agree that in theory and in practice it is safer to do these operations under the spray, although there may be no objection to using any other antiseptic, such as hydronaphthol, instead of the carbolic acid. In fact, it seems to me far preferable.

With regard to the methods of perforating the bone, the English and continental surgeons differ. The former prefer usually the trephine and cutting bone forceps; the latter, the hammer and chisel. American surgeons for the most part agree in practice with the former, and the writer, for his own part, can not avoid the conclusion that the first exploration, at least, can be made more readily with the trephine than in any other way. Those whose facilities permit the use of the surgical engine will find it to be an admirable adjunct to cranial surgery.

What shall be done with the Pieces of Bone removed?—Since Macewen has taught us how to save these fragments and restore them to place, the method has been widely tried and generally commended, and it is now the proper thing to put all pieces of bone thus removed at once into a warm antiseptic compress to be utilized at the close of the operation. Spitzka, among others, has paid particular attention to this technical point. At an autopsy three months after operation he found the reinserted button of bone in part firmly reunited ; it was raised above the surrounding level, but the inner contour of the calvaria was restored, and the dura was not adherent. He concludes that buttons of bone, aseptically reimplanted, may, at least in young persons, become reunited to the calvaria, and that, even in the event of failure of bony union, they are perfectly harmless. He regards it as very essential that they be replaced, and illustrates this by a case-record to the point.*

Dr. Mills deems it inadvisable to reinsert large or irregular areas of bone, or those with very irregular edges or inner surface, until they have been smoothed off. But, as we know, whenever it may be unwise to restore an integral portion of the bone it may be chipped into minute pieces, and these strewn over the external surface of the dura before laying the skin-flap in place.

Dr. Dercum† has, furthermore, called attention to the inadvisability of preserving fragments of bone in a bichloride solution for so long a time as might be necessary in certain cases, and he thinks, most wisely, that the risk of long-continued immersion would be greatly diminished by keeping them in fresh blood-serum, or in the physiologist's salt solution (7.5 *pro mille*).

Treatment of the Dura Mater.—This should be incised, according to Horsley, around four-fifths of the circumference of the area exposed, at a distance of an eighth of an inch from the edge of the bone, so that it may be afterward conveniently stitched. Arterial branches running in its substance may have to be severed, but may be easily secured. Portions of this membrane which adhere to underlying tumors are usually considerably altered. If the case is of recent origin, the dura will be found highly vascular ; in advanced cases it may be yellowish, and in some instances, on separation from the growth beneath, it is found to be of a dirty-reddish color. Whenever adherent, it should be freely excised. After division of the dura, one must first look for protrusion of the brain. Horsley maintains that marked protrusion of the dura indicates pathological intra-cranial tension, obviously a sign of great importance. Next, the color of the brain should be observed. It will be remembered that the cerebellum has normally a different appearance from that of the cerebral cortex. In the latter, it is said that the existence of a yellowish tinge or a pink lividity indicates the existence of a tumor beneath. In the light of some pathological experiences of his own, Jastrowitz advises us to trust to the sense of touch, when in doubt, rather than to that of sight, in estimating the condition of the brain after exposure.*

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* Trans. of the Am. Neurol. Assoc., 1887, p. 22.

† Polyclinic, June, 1888.

It has more than once happened that, even after careful exposure of the brain according to the best rules of localization, uncertainty has arisen as to which convolution was the desired one. In such cases the battery has been applied, by Horsley, Keen, and Deaver, with satisfactory result. It will therefore always be well to have this adjuvant at hand.

The condition of the vessels must be observed, note being taken of yellowish-white patches in the perivascular lymphatics, which are indicative of old mischief. Next, a species of manipulation should be practiced in order to detect either fluctuation or an increased resistance denoting a tumor; nothing being found upon the surface and no tension being discovered indicative of deeper lesion, further exploration can be conducted with a small aspirating needle, or with a probe or grooved director. The general harmlessness of the introduction of a small hollow needle into the brain has been clearly demonstrated already.

Further Investigations.—If the symptoms have been sufficiently grave to call for so much exploration, it is not likely that the careful separation of the convolutions with the rounded point of the probe, or even the pushing of the same through the layers of the cortex, will give rise to any serious disturbance, while the needle or the probe may reveal the presence of pus, or, by the increased resistance offered by a tumor, may indicate its presence.

Should a tumor present or be discovered, the method of its removal will depend somewhat on its depth and character. Incisions for the removal of tumors should be made perpendicularly to the surface of the brain, both because bleeding can be more readily controlled and because, by these vertical cuts, the paths taken by the fibers of the cortex to the internal capsule are divided to the smallest possible extent; in other words, all incisions should be directed into the corona radiata. When it is possible, a portion of each motor center should be allowed to remain, so that absolute paralysis of a given part may be prevented, so far as this can prevent it, since total destruction or ablation commonly means absolute loss of motor power for all time in the part supplied therefrom.

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* Deutsche med. Woch., No. 11, 1888, p. 210.

Removal of a layer of cortex, whether normal or abnormal, does not leave, as might be supposed, a prominent gap with vertical sides, for in a short time the most depressed portion is made to bulge almost to the level of the intact parts surrounding. In addition, the cut edges are also slightly everted, and if less brain is removed than bone, these are extruded into the opening in the skull; thus, owing to mechanical arrangements, there is a continual normal tendency to hernia cerebri. But Bergmann and others have shown that the tendency to hernia cerebri is in inverse ratio to the area of bone removed, so that there is the greatest danger of hernia when but a small trephine opening has been made. As experience has extended in these cases, we are taught that it is to the best interest of the patient to remove brain tissue to an extent greater than was at first supposed—that is, one should go as wide of lesion in the brain as he would of the apparent border of the ulcer in excising a cancer of the lip. Bergmann and Horsley have also made plain that which was not previously generally appreciated—that in all operations for epilepsy of traumatic origin the portions of the cortex nearest the evident lesion should be freely removed.

Drainage.—The question of drainage must be decided by the circumstances attending the case. An abscess must plainly be drained so long as pus is discharged, but the wound or cavity left after antiseptic removal of a tumor should hardly ever, if ever, be drained for more than twenty-four or forty-eight hours, and this draining may be effected by rubber tubing or strands of horse-hair or catgut.

Closure of the Wound.—All hæmorrhage must first be checked; suitable drainage is then provided for, according to the necessities of the case. We wish, so far as possible, to obtain primary union; also to make efficient pressure upon the brain to check tendency to protrusion. During the first twenty-four hours there is usually a slight or continuous oozing of blood and serous fluid from the fresh surfaces, but in all save abscess-cases the drainage-tube may be removed on the succeeding day, and the wound dressed with a certain amount of pressure over the flap. Any exudation that subsequently collects in the cavity or over it will thus be retained and may give rise to some pain in the wound, with apparent distension, so long as pressure remains. Symptoms from this are not severe. The wound may be left with confidence that the fluid will be reabsorbed in due time and that pressure will be the best check to protrusion. In case the primary union be broken up by this pressure, it may be regarded as simply a safety valve action ; otherwise the increased pressure will merely compel the lymphatics to more rapid absorption. According to Horsley, the cavity is gradually filled with a delicate pink, spongy connective tissue, whose meshes contain this fluid, which forms a plastic barrier between the scalp and the brain, and which subsequently separates the brain from its environment by a cushion of soft, normal connective tissue. Fine catgut should be used for closing the dural wound, and catgut or silk, as may be necessary, for the scalp.

How much Brain may be removed?—As a study of the numerous recorded cases will show, we know scarcely any limit as to the amount of either brain or bone that may be removed. Certainly we can unroof large areas of the brain, including ten or a dozen square inches if need be, feeling confident, from the assurance given by many surgeons, that the larger the opening the less the danger of hernia cerebri. So, too, with the brain itself. Spitzka and others maintain that, if in animals, so long as the *brain axis* is not interfered with, life may go on undisturbed, we have not reached the limit of what may be accomplished in man, since he has removed the brain in dogs to an extent which a few years ago would have been deemed incredible.

Dangers of the Operation.

In considering the main sources of danger to a patient after removal of a brain tumor, we must perhaps first mention any lack of or failure in aseptic precautions. If any operation seems to call loudly for such measures it is such a one as this. The records of the past are full of the fatal results of such omissions ; and yet we meet, just here, with facts which constitute a strange anomaly. We know too well the danger attending the entrance, ordinarily, of foreign or septic material beneath or even in the scalp. Still Spitzka assures us that he has deliberately injected a drachm of the foulest street mud he could procure into the thalamus after trephining. The dog recovered without untoward symptoms. In the arachnoid of the ponto-chiasmal lamina two large masses of dirt were found after the dog had been subsequently killed ; a third portion of it was found in the arachnoid lamella on the basilar surface of the oblongata.* His general inference from experiments is that the oftener a dog's brain or dural spaces are insulted by the insertion of indifferent or virulent substances, the greater becomes their resisting power to injurious agencies such as prove fatal to an animal operated on for the first time. In other words, that final immunity is gained by repeated attacks. Let us, notwithstanding, not judge from these interesting experiments that we can afford to disregard any precaution which the best practices of the day afford.

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* Transactions of the American Neurological Association, 1887.

But the principal immediate dangers are two—*i. e.*, *hæmorrhage* and *œdema.*

Hæmorrhage.—When the pia is cut, its vessels may bleed freely, so that ligature or its equivalent may be demanded. The brain substance is not likely to give rise to alarm on this account. But that disastrous hæmorrhage from unexpected sources may occur is a lesson we may learn from Birdsall and Weir's case; here two bleeding points were discovered—one from near the straight sinus, probably belonging to the pedicle of the growth, the other probably a terminal branch of the posterior cerebral artery. Direct pressure checked their flow and the cavity was filled with iodoform gauze. Nevertheless, oozing continued and the man died of loss of blood nine hours later.

Dr. Keen found in one of his cases that the vessels were so friable that if one end of the catgut ligature were pulled harder than the other the vessel would be cut through; hence absolute equality of traction may be essential.

Bergmann advises, as a rule, to tie arterial stems of appreciable size, and condemns the tampon if it can be avoided. In the brain one may ordinarily cut to a depth of four centimetres before an artery spurts—before there is even more than an oozing; but when such a branch as one from the posterior cerebral on the basal surface of the occipital lobe is cut, experience shows that it must be secured. When necessary one may do as he did in one case: tampon the cavity with iodoform gauze, and make secondary suture of the flap forty-eight hours later if need be. After inserting the tampon the dural and skin flaps are laid over it and an absorbent dressing applied over all. This tampon must be a rolled-up wad of gauze, covered by as many more as may be needed, till the level of the skin is reached. It thus effects *compression* and *drainage*, and is much better than an inefficient plugging with a strip packed down in the ordinary manner. The subsequent removal of all this, with secondary suture of the flap, may require a repetition of the anæsthetic (chloroform), but this is much preferable to a failure by other methods.

Spitzka speaks of the danger of hæmorrhage beneath the button of bone from too sudden relief of counter-pressure made to repress any tendency to hernia cerebri ; also of the danger in exposure of large brain areas in old persons with feeble vascular walls, from relief of pressure upon the intra-cerebral vessels—practical points worth noting.

On the other hand Jastrowitz raises the question whether in some cases of cerebral hæmorrhage we ought not to trephine simply for relief of intra-cranial pressure in order that absorption may more easily take place. He shows that in most cases of brain tumor the *pressure* is a much more serious factor in the fatal result than any other element. Fifty years ago Magendie made experimentally cerebral hæmorrhages in animals, and after they were comatose and paralyzed he quickly opened their skulls, after which they recovered consciousness and part at least of their muscular power.

Œdema.—A second danger is that of acute brain œdema. This led to the loss of one of Bergmann's patients five days after operation. This sudden transudation, which perhaps is an exaggeration of the process by which the cerebro-spinal fluid is produced, may be brought about in two ways—either by increase of intra-arterial pressure, or by obstruction of the venous channels of escape. Production of the normal fluid seems to be in proportion to the former ; obstruction to venous return must be followed by similar obstruction to lymphatic return. Under this accumulation, however brought about, the brain becomes more sodden. Removal of a portion of the cranium is in effect a diminution of the pressure normally exercised on its contents. Such relief of pressure is here, as elsewhere, often followed by a reaction with production of excess of fluid. Magendie's often-repeated experiment, showing how rapidly the cerebro-spinal fluid may be reformed after it has been freely drained off, is here very instructive.

Danger of œdema is probably greater after temporary diminution of blood-pressure as a result of considerable loss of blood and through interruption of the venous blood-stream. In large intra-cranial tumors there is an increase of fluid particularly in the brain cavities—an increase which, after the onset of typical pressure signs, finds its expression in choked disc. It is well known how pressure upon the vena magna Galeni leads to hydrops ventriculorum. If there be added to these conditions of such profuse substitution of fluid yet others which increase production and limit escape—such as the effect of an operation—then one may understand how œdema may quickly supervene or be rapidly increased if already present.

When a fatal brain tumor has produced severe pressure symptoms like stupor or coma, one may surely rely on finding marked œdema at the autopsy. And since this œdematous condition is rather likely to be increased by operation, it is not strange that it should prove fatal within six or twelve hours.

Results.

In closing this brief casuistic there remains to be considered only the important feature of results. These I have thought best to present in tabular form. From this table I have excluded every case in which the operation was not dictated alone by a study of its phenomena relating to the nervous system. I have omitted all trephinings for recent hæmorrhage,* since these are not founded primarily on the principles of localization in our present acceptation of the term; also all operations for epilepsy or insanity or other trouble, when the operation has been apparently performed on account of external scars or on generalized principles. Every recent case of "primary operation" has been omitted. A very large number of cases is thus excluded—cases which have a deep interest and significance of their own, and yet which are not strictly germane to our subject.

The table includes every case which I have been able to find where the expiration or the complete operation was practiced on account of lesions previously diagnosticated, according to the principles of cerebral localization and without reference to scars or surface markings, although probably the corroborative evidence which they might afford could not be disregarded. In this table are included three of my own cases, never before reported, the first of which antedates Mr. Horsley's first case, according to his published table of personal cases, by three months. It has been difficult to decide, in a few instances, whether a given case was entitled to a place in this collection or not. This I have had to determine on perhaps insufficient data, and accordingly desire to express hope that I have not been guilty of any injustice in either direction.

My summary of cases and table include sixty-three cases. Certain data deduced from these will be of interest. The deaths were seventeen in number, of which only *five* can be justly laid to the operation itself. Fifteen of these cases were abscesses, subdural or subcortical. In eleven the lesion was a tumor, exclusive of tuberculous nodules. Of cysts, properly speaking, there were twelve. The twenty-five other cases were of a miscellaneous nature. In three cases the true nature of the lesion was not revealed during the operation and was only discovered at the autopsy. In two cases in which no palpable or visible lesion was discovered at the time of operating, the symptoms which led to its performance were nevertheless relieved, though nothing but careful exploration was practiced.

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* Mr. Jacobson has collected seventy such operations with fifty-seven deaths.

Of the 63 operations, 17 have been done by American surgeons. Those who have themselves operated more than once are, with their operations, Macewen, 12; Horsley, 11; Bergmann, 4; Keen, 3; Weir, 3; and Park, 3.

CASES.

1. MACEWEN, 1879.—Boy who had had a fall six days previously from which he apparently recovered; six days later convulsions; paresis of left arm and leg; phenomena indicating lesion of lower part of fissure of Rolando. That portion was excised; the dura was found bulging; two ounces of fluid, coagulated blood removed; patient rapidly recovered.—"Med. News," Aug. 18, 1888; "Brit. Med. Jour.," Aug., 1888, p. 303.

2. STIMSON.—Male, twenty-six years, hit on the right side of the head with a stone. No fracture found, but a scalp wound. In the fifth week hebetude and headache. In the eleventh week was seen to have wrist-drop on the left side. Operation, July 20, 1880. No anæsthetic, only slightly sensitive to pain. Trephined above upper end of scar, at a point about back of the middle of the post central gyrus, Two ounces of pus drawn from an abscess at opening but a quarter of an inch below the surface. A probe was passed two inches. The patient died nine hours after operation. On autopsy, there was found a collapsed cavity at a point "in the parietal lobe behind the lower part of the ascending parietal convolution, from which it was separated by a shallow sulcus."—"Archives of Medicine," 1887, v., p. 218.

3. MACEWEN, 1881.—Large cerebral abscess in temporo-sphenoidal lobe. Patient aphasic. Sudden signs of abscess having burst into lateral ventricle. Operation while patient was *in extremis*. Abscess reached at a depth of a quarter of an inch, and several ounces evacuated. Autopsy proved it to be an old encysted abscess.—"Brit. Med. Jour.," Aug. 11, 1888, p. 304.

4. MACEWEN, 1883.—Case of brachial monoplegia. Operation. Lesion in white substance of motor cortex of middle of ascending frontal convolution, found to be an old extravasation of blood, around which encephalitis had occurred, inducing irritation and compression—"Brit. Med. Jour.," Aug. 11, 1888, p. 304.

5. MACEWEN.—Boy aged three. Brachio-crural monoplegia with rigidity, resulting from injury eight months previously. Operation (no date given). Large, thick-walled, subdural cyst found, and a spiculum of bone pressing on the brain. Almost complete recovery.—"Brit. Med. Jour.," Aug. 11, 1888, p. 306.

6. MACEWEN.—Patient with ptosis, mydriasis, paresis of occular muscles of left side and right facial paralysis, and paresis of right arm. Diagnosis of abscess in temporo-sphenoidal lobe. Operation (date not given). Evacuation of three ounces of pus. Rapid recovery.—"Brit. Med. Jour.," Aug. 11, 1888, p. 307.

7. **Wernicke and Hahn.**—Male, aged forty-eight. Hemiopia, paralysis of right leg, paresis of right arm, speech unaffected. Operation, August, 1881. Trephining over occipital bone; considerable deep resistance; deep exploration; pus found at depth of four centimetres. Death six days later. Tuberculous abscess found in left temporo-occipital lobe perforating into the ventricle.—Seydel, "Antiseptic und Trepanation," p. 142.

8. **Polaillon.**—Male, aged fifteen years. Blow on skull seven months and a half previously; aphasia and paralysis of right arm and leg. Diagnosis of blood-clot over affected centers. Operation, 1882. Trephining over left motor area; clot found in upper part of fissure of Rolando; death in six days. Autopsy showed two abscesses in brain beneath the cortex.—Seydel, *loc. cit.*, p. 137.

9. **Macewen**, 1883.—Male, thirty-five years of age. Had gonorrhœa for three months, followed by bleeding from the ear. Unconscious for twelve hours. Complained of loss of strength in left arm and leg; later right facial paralysis. Diagnosis of meningitis from hæmorrhage and brain lesion of the middle portion of the right gyrus centralis anterior. Trephining over right temporal bone. Dura when exposed unevenly red; after incision there was an escape of clear fluid. Along the ascending frontal convolution there was a yellow opaque membranous mass which reached into the fissure of Rolando, which was extirpated and the button of bone replaced. Wound healed in eight days, and in six weeks recovery was complete. Macewen's diagnosis was tuberculosis. Bergmann considers it to have been a gumma.—"Lancet," 1885, p. 881. *Vide* also Bergmann, *loc. cit.*

10. **Macewen**, 1883.—Female, aged twenty-five. Syphilitic history; paralysis of left side, of gradual onset, with prickling sensations. Removal of a square inch of right parietal bone. Surface of brain covered with opaque yellow mass over the middle and upper thirds of the ascending frontal convolution and the sulcus frontalis. After incision, in the upper anterior part of the gyrus anterior, where the brain matter seemed more resistant, some brown, cloudy fluid escaped. Re-implantation of bone and rapid healing. At the end of the first week there was movement in fingers and toes; after eight weeks good motility and complete recovery. After two years, condition good.—"Lancet," 1885, p. 934.

11. **Macewen**, 1879.—Patient with mental symptoms and convulsions limited to right side, commencing in face and arm and later involving the leg. Diagnosis of lesion involving lower and middle portion of the ascending frontal convolution. Application of trephine. Tumor of the dura mater removed, along with the membranes so far as they were involved; rapid recovery.—"Med. News," Aug. 18, 1888, p. 170; "Brit. Med. Jour.," Aug. 11, 1888.

12. **Macewen.**—Male, twenty-two years old. Epileptiform convulsions, appearing on an average every five minutes, limited to the tongue, right facial muscles, and platysma on the same side. Eight years previously had received an injury to the head, after which right arm became weak. Diagnosis of lesion of ascending frontal convolution. Operation; cyst found in ascending frontal convolution, size of a filbert, surrounded by inflammatory zone. Extirpation of entire lesion; rapid recovery and return of motor power.—"Med. News" Aug. 18, 1888.

13. Macewen.—Girl, seven years of age, with frequently recurring epileptiform seizures. The first sensation was experienced in great toe of right foot, which was soon extended in clonic spasm, and sometimes was followed by contractions of entire limb, with motor paralysis in affected parts. Diagnosis of lesion, probably multiple, in upper region of ascending frontal convolution, thought to be possibly tubercular. Exposure of this region. A few tubercular nodules were discovered on the surface. On careful palpation, discovery of a circumscribed nodule in the cerebral substance. On incision, this was found to be a tubercular mass, size of a hazel-nut, which was easily shelled out. Rapid recovery without disturbance.—"Med. News," Aug. 18, 1888.

14. Macewen, 1883.—Adult male. Injury a year previous, followed by melancholy and intense headache. Behind the angular process of the frontal bone was a slight osseous depression which could not account for his symptoms. No motor phenomena, but discovery of psychical blindness. Physically he could see, but there was conveyed no mental impression. Diagnosis of lesion in the angular gyrus. On exposure of the part, a detachment of internal table was found, which had caused pressure on the part beneath. The depressed bone was removed and reimplanted in proper position. Rapid healing and wonderful benefit to his general condition.—"Med. News," Aug. 18, 1888.

15. Leo.—Male, aged twenty-five. Struck on the back of the head with a brick when thirteen years old. First fit at nineteen while sitting at work. "Felt himself swelling immensely; all his surroundings seemed to become grossly enlarged; he uttered a sharp cry." He had a convulsion, and after it, remained comatose for a time. Before the fit he uttered a prolonged cry, and his head turned to the right and backward. The fit was limited to the right side of neck and right arm, and of short duration. Recovered with a start of surprise. At last could not repeat words distinctly except monosyllables, and could swallow but very little. Operation, August 11, 1882. Disc of bone an inch in diameter was removed from right side, an inch and a half above and behind the mastoid process, over squamous ridge of temporal bone. The patient recovered.—"Am. Jour. of Neurol. and Psychiatry," vol. ii., 1883, p. 38.

16. Durante.—Fibro-sarcoma extending across middle line from the left anterior cranial cavity; destroying lamina cribrosa; pressing superior orbital plate downward; extending posteriorly nearly to sella-turcica; with extensive atrophy of left frontal lobe. Operation, May, 1884. Incision from left internal canthus upward and outward toward temporal region; large piece of cranium removed, by hammer and chisel, downward as far as superior border of orbit. Tumor removed without much hæmorrhage; drainage made by tube into the nose; wound closed; tampon of gauze around drainage-tube for ten days. Patient discharged cured. Previous symptom; protrusion of the left eye, anosmia, weakness of memory, uncertainty of motion, tendency to depression and silence. Three months after operation, mental depression and disturbances of memory had disappeared.—"Transactions of the Ninth International Medical Congress," vol. i,, p. 570.

17. Bennett and Godlee.—Male, twenty-five years of age. Headache for four years; violent attacks of emesis and suffocation; intelligence and spe-

cial senses not affected; double optic neuritis; paralysis of left hand and fingers; loss of rotation of forearm; limitation of motion of left shoulder; slight paresis of left leg and left side of face. Operation, November 25, 1884. An opening two inches by an inch and three quarters was made on the right side over upper third of fissure of Rolando. Enucleation of a tumor the size of a walnut: bleeding checked with galvano-cautery; cavity drained. Tumor found to be glioma. Good result for four days, then suppuration and œdema of face and scalp. A little later hernia cerebri, suppurative basilar meningitis, etc. Death four weeks after operation.—"Lancet," 1884, vol. ii., p. 1090, and 1885, vol. i., p. 13.

18. MILLS.—Male, aged forty years. In 1873 had an injury to the skull with supposed fracture, followed by violent reaction, the convulsions increasing in severity and number during the ensuing eight years. All this time he suffered from headache, which was sometimes intense. Three years after the injury his eyesight began to fail and was almost lost. Just before entering the hospital paresis of the right arm and leg supervened. In the hospital he suffered from convulsions with spasms of the right arm and leg, alternating with rigidity; eyes fixed, deviating to the right; pupils dilated, and between convulsions oscillating horizontally. During the night convulsions followed at intervals of fifteen minutes; toward morning he became comatose, and when seen by Dr. Mills was in this condition. Dr. Mills and Dr. Hearn decided to trephine on the left side, about the Rolandic line, concluding that the convulsions were due to involvement of the dura. Operation, without anæsthetic, 1884. Dura found adherent to overlying bone; no depression nor fracture of internal table apparent. Soon ofter the operation he became quieted, the convulsions were less marked, and he was again able to swallow and take nourishment. The following day he recognized his mother and spoke intelligently. During the eighty hours after the operation he had a few mild convulsions, and at the expiration of this time died quietly. On autopsy, there were found on the left side, at the site of the operation and in its neighborhood, firm adhesions of the dura to the pia and brain substance. The tissues as a whole formed a common mass; the dura was also adherent to the skull; the membranes showed necrobiotic spots, and the cause of death was shown to be a pachymeningitis.—Reported by Roberts, "Annals of Surgery," vol. ii., p. 112, 1885.

19. GUSSENBAUER, 1884.—An eighteen-year-old scholar sustained a perforating gunshot wound of the right side of the forehead. The contused and lacerated wound healed after suppuration, and was followed by necrosis of the superficial part of the bone. Later symptoms of compression of the brain appeared, with certain local and motor symptoms, from which Gussenbauer diagnosticated abscess of the brain and trephined at the injured spot. After exposure of the brain he detected a deep fluctuation, made a deep incision, and evacuated a deep abscess. Complete recovery followed, complicated only by a tendency to epileptic spasms, which required subsequent medicinal treatment.—"Prag. med. Wchschft.," 1885, Nos. 1 to 3.

20. TRUCKENBROD.—Male, aged twenty-eight. Left otorrhœa. Pain on top of head and occiput; vertigo; fever. Several ear and mastoid operations. Paresis of right side of face. Stuttered while reading and used wrong words. Did not remember the number of his children, his own age

or name. Aphasia marked. Œdema behind and above ear. On January 31, 1885, opened skull above the ear and removed a cupful of pus from under dura; abscess as big as a small orange. Bright and well next day. Steady recovery, which resulted in complete cure for four months.—"Archiv. of Otol.," 1886, xv., pp. 176–185.

21. HIRSCHFELDER and MORSE.—Male, thirty-seven years old. Headache, epileptoid attacks, vertigo, amaurosis, motor and sensor paralysis of left arm, contractures of arm and left side of face. Operation, February 15, 1886. Three trephine openings, making one opening of three inches in diameter, in right parietal bone over fissure of Rolando. Tumor found to be diffuse and very soft, of which only a part two centimetres and a half in size could be removed. Tumor found to be glioma. After the eighth day, until death, a profuse flow of sanious bloody pus with gliomatous elements. No autopsy.—"Pacific Med. and Surg. Journ.," April, 1886, p. 210.

22. R. PARK.—Girl, aged fourteen. In August, 1881, fell from window, contusing right side of the head. Total unconsciousness for ten days, followed by left hemiplegia, which gradually disappeared. Two years later had her first fit: convulsive seizures beginning in right arm, involving first the right side of the body. Depression of bone an inch and a half above left ear. Diagnosis of cystic degeneration of blood-clot in the neighborhood of center for right arm. Operation, February 24, 1886. Bony defect two centimetres and a half in diameter. This was found filled in with fibrous membrane, over which the periosteum was adherent; underneath this a cyst. Large opening made with trephine and bone forceps and a cystic cavity three centimetres and a half in diameter uncovered. Excision of overlying dura and removal of cyst. Immediate union of wound, great improvement, though she still has epileptoid seizures when her digestive organs are deranged. Reported for first time.

23. HORSLEY.—Male, aged twenty-two. Scar in brain from old depressed fracture of skull. Fits beginning in the right leg. Twenty-eight hundred and seventy fits during the first thirteen days of his stay in the hospital. Complete paralysis of right arm and leg. Diagnosis of lesion involving the end of the superior frontal sulcus. Operation, May 25, 1886. Free incision and excision of lesion, which was found to be cicatrical; primary union; no drainage after second day. General improvement, paralysis unchanged, but has had no fits since operation.

24. HORSLEY.—Male, twenty years of age. Repeated attacks of pleurisy. Since the 15th of January, 1884, began to suffer from clonic cramps in left thumb and index finger, first severe attack being in March, when he fell to the ground. During 1885 no pronounced epileptic attacks. Seizures began in the fingers of his left hand, extending up the arm. In April, 1886, had practically lost power of his left arm, with severe pain from occipital to right parietal region. Diagnosis: Lesion of uncertain nature in ascending central convolution at centre for finger. Operation, June 22, 1886. After exposing brain there appeared a large tumor. This was superficial and seemed half an inch wide. Excision of this with a surrounding zone of healthy tissue. It was found to extend somewhat deeply into the cortex. Tumor found to be tuberculous, composed of two caseous masses. Nearly all the wound healed immediately. On the day following the operation, paralysis of left arm: later, all motility was recovered save that in the index finger.

25. Bergmann.—Male, aged nineteen. Bullet wound of right temple; unconsciousness. Wound healed in three weeks without pus. Three months later sudden loss of consciousness, occipital pain, spasms of several muscles; subsequently atrophy of optic disc on right side, local temperature elevated, and paralysis of left side of face. Diagnosis of abscess near lower third of right fissure of Rolando. Operation, June, 1886. Three openings made, no pus found, wound packed with iodoform gauze; three days later spontaneous rupture of an abscess and evacuation of a large quantity of pus. Condition much improved; two days later second small abscess emptied in the same way. Patient eventually died. On autopsy, a third abscess was discovered.—"Wierner med. Presse," Nov. 27, 1886.

26. Horsley.—Man, aged twenty-four. Old punctured fracture of skull involving cortex in motor area, causing severe epileptiform seizures in groups every three weeks. Slight paralysis of right arm and face; dull headache. Operation, July 13, 1886. Trephining at seat of external scar; removal of small piece of inner table, which was depressed into a traumatic cyst; surrounding brain substance also removed. Primary union, general improvement, only three fits since operation.

26. Hulke.—Female, fifty-five years of age. Long subject to discharge from right ear mouth drawn to left; intense pain in right ear and right side of head; stiffness of nape of neck. These symptoms for four days, then drowsiness deepening into coma. Diagnosis of abscess in cerebellum. Operation, April, 14, 1886. Immediate effects striking, breathing easier, cyanosis of face relieved; coma less deep, but consciousness never returned, death following morning.—"Lancet, July 3, 1886, p. 5.

28. Bennett and Gould.—Male, aged thirty-six. Blow on right side of the head six years before. Six weeks later had fits limited to the left side; continued since at intervals of about one week. Fit followed by violent mania lasting several hours or even days; he was dangerous then. He became suddenly senseless and had general convulsions, most marked on left side. Fits lasted from five to ten minutes. He saw a red light just before the fit came on. Operation, July 8, 1886. Trephined at site of cicatrix from old injury due to fall. This was three inches and a half from the median line, and two inches and three-quarters back of the meatus. Bone and piece of dura were removed (both normal); brain explored and nothing found. Wound closed. Uninterrupted recovery, and five months after operation had not had a fit. Bennett located the trouble and site of operation at the angular gyrus.—"Brit. Med. Jour.," 1887, vol. i., p. 12.

29. Horsley.—Male, aged thirty-eight. Left side paralyzed, with epileptiform seizures beginning in the left shoulder; in a semi-comatose condition for ten days previous to operation. Operation, September 23, 1886. A firm glioma weighing four ounces and a half found in the center for left arm: excision along with surrounding zone of brain tissue. Drainage till second day. Wound nearly all healed by immediate union. On eighth day aspiration of a little serous fluid for relief of pressure. Sensation returned and was complete, with consciousness, for two months and a half, when rapid return of growth took place. Patient died in March, 1887.

30. Horsley.—Boy, aged ten. Irritative lesion causing epileptic seizures beginning at left angle of mouth. Three to six fits every day—a moral

imbecile. Incomplete paralysis of face, volition, and speech. Operation, October 19, 1886. Exposure of facial center, removal of cortex composing the two centers, determined at the time by faradaic battery. Primary union; general improvement in all respects.

31. HORSLEY.—Male, aged thirty-seven. Blow on head fourteen years previously; first fit three years later; dull, bad memory; paresis of right arm and leg; epileptic attacks. Diagnosis of cicatricial lesion in and behind center for movement of hallux at upper end of Rolandic fissure. Operation, November 8, 1886. Large cystic cicatrix at point diagnosticated. Excision of dural cyst was incomplete owing to collapse of the patient. Improvement of motor power of the upper limb only, and of sensory power in both; mental condition much improved; a few seizures during first week after operation, then only a slight attack once a week.

32. R. PARK.—Male, aged forty seven. August, 1885, thrown from a wagon; totally unconscious for sixteen hours; slight paresis of right leg; paralysis of right arm, nearly complete aphasia. First epileptic attack four months after injury. Of late these occur very frequently. No scar or depression. Diagnosis: cystic degeneration of blood-clot involving centers for right arm and speech. Operation, November 17, 1886. After trephining, dura bulged into the wound; fluid felt underneath; bone cut away with surgical engine. A cystic tumor found, containing an ounce and a half of clear fluid, about five centimetres in length by two in the other directions. This was freely opened, its interior scraped, its margins sewed to those of the dura, and the whole cavity drained. Wound healed immediately without disturbance. Result has been but partial improvement; no marked improvement in speech. Reported for first time.

33. HORSLEY.—Man, aged thirty seven. Severe and intractable headache of three years' standing, incapacitating him for work. Operation, November 12, 1886. Trephining at seat of pain, removal of part of parietal bone, whose inner table had been perforated and was being eroded by a Pacchionian body. Rapid recovery with relief of pain.

34. MAY.—Male, aged seven. Severe and persistent headache, chiefly frontal, with vomiting; conjugate deviation of the eyes to the left, and paralysis of right external rectus muscle. Nearly blind from bilateral neuroretinitis. Staggering gait, especially backward, and sometimes to the left; unable to stand. Retraction of the head, absolute blindness, and nystagmus. No knee-jerk on right side. Much emaciation. Operation, October 8, 1886 (or after, not stated). Occipital bone trephined on right side under superior curved line, midway between it and the foramen magnum. Dura bulged very much. Dug out cerebellum with small spoon-handle, and hard tuberculous tumor size of pigeon's egg; trifling hæmorrhage. Death in a few hours. No autopsy permitted.—"Lancet," April, 1887, vol. i., p. 768.

35. HEATH.—Male, aged twenty. Intemperate. A fall when six years of age, and in December, 1886, another fall on the right temple, from which the next day he lost sight in the right eye. First epileptic attack about Christmas, 1883. Constant headache. Not very intelligent. Right optic atrophy and commencing left. Right anosmia. Left face, arm, and leg paretic. No anæsthesia. Head, arm, and shoulder of left side convulsed during fits. Spot tender on percussion about an inch and a half behind external angular

process of frontal bone and two inches from zygoma. Operation, October 13, 1886. Trephined over tender spot and bone removed further forward with forceps. A deeply seated tumor found fixed to the base of the anterior fossa. Operation abandoned. Thirteen months after operation the patient was in fair condition, but troubled with headaches and epileptic attacks returning with greater frequency.—" Lancet," April 7, 1888, i., p. 67.

36. HORSLEY.—Boy, aged four years. Almost complete paralysis in his right arm and leg; semi-comatose; having three to fourteen fits a day. Diagnosis: probable hæmorrhagic cyst beneath the motor cortex. Operation, November 29, 1886. Trephining over left motor area; exploration of brain by incision; nothing found; no harm done. Rapid recovery without drainage; no fit for a month; then six slight ones, and none since.

37. HORSLEY.—Male, aged thirty-seven. Headache; gradual onset of paralysis of right arm and hand, and paresis of right leg; epileptiform attacks beginning at the fingers, which had ceased three months before operation. Operation, December 7, 1886. Removal of tumor weighing four ounces and a half. Immediate union of nearly all the wound; eventual recovery.

38. BERGMANN.—Male, aged sixty-six. External tumor on temporal bone, of twenty years' standing, which suddenly, in the spring of 1886, began to soften, after which began symptoms of aphasia and trouble in right arm. By December, 1886, right arm nearly completely paralyzed. Operation, December 10, 1886. Removal of tumor by chiseling away its margin; bone found perforated; brain invaded by tumor of the size of a small apple. It was necessary to remove a layer of brain-tissue in order to be sure of complete extirpation; ligature of several branches of the middle meningeal; extirpation of a considerable portion of the superior longitudinal sinus; hæmorrhage free but controllable. Tumor sarcomatous. Death on fifth day from intense œdema of the brain.—" Archiv für klin. Chir.," vol. xxxvi., p. 831.

39. HORSLEY.—Male, eighteen years of age. Increasing headache; vomiting; optic neuritis; diminishing muscular power of all limbs, especially of left arm and leg; affection of the sphincters; epileptic seizures, with turning of head to right; consciousness good; had been in bed one year. Operation, December 17, 1886. Trephiningover right hemisphere of cerebellum; removal of a tuberculous mass weighing seven drachms. Death nineteen hours after. Autopsy revealed disseminated tuberculosis.

NOTE.—Horsley's cases, given above, were reported in his brochure on "Brain Surgery," from "Brit. Med. Jour.," Oct. 9, 1886, and April 23, 1887.

40. MARKOE.—Reported at a meeting of the New York Surgical Society, October 25, 1887.—Man, aged twenty-five. In 1879 he fell eight feet, striking on his head; unconscious for some time. Brain fever followed, and two months after the accident he had his first convulsion. Convulsions recurred at irregular intervals for two years, then became less frequent, and ceased for two years. In January, 1887, while bathing, he struck his head, and within a week had another convulsion, which was subsequently repeated. On examination, his head was irregular shape, the right parietal region protruding, the left parietal region markedly depressed. In the center of the left parietal region was a marked depression, and all pain was referred to this spot. His convulsions were not preceded by aura, nor did muscular

spasm begin at any single point. The fits increased in frequency and severity, and were followed by great excitement. Operation, January 27, 1887. Large trephine applied over the depressed area. On exposure, the dura did not bulge, but fluctuated, and between the dura and the brain a firm, hard substance was felt. On reflecting the dura, a cyst was found underneath containing a drachm of fluid, and presenting two firm masses lying close together, about an inch in diameter. These were turned out of their bed, and the cortex found to be exposed beneath them. The dura was closed, and the wound dressed in the usual way with catgut drainage. Operation followed by some mental excitement, with amnesic aphasia for several days, and with some paresis in his right arm. Wound healed kindly. Discharged well on February 19th. Since this time he has so remained. The masses thus removed were of anomalous construction; they were decided by Dr. Prudden to be developed growths of aberrant brain-tissue.

41. Bergmann.—Male, aged twenty years. When four years of age fractured his skull by injury to left side of head. Soon after, paresis of right side appeared. Two years later, attacks of vertigo; later still, cramps; loss of consciousness; epileptic spasms; gradual failure of mental and physical powers. At the time of operation he was confined to bed. There was atrophy of the right arm and leg; the arm and fingers were constantly extended; and he had at least two fits a day, beginning invariably in the right fingers. Scar on left side was over center for the right hand. Operation, February 2, 1887. Adhesion of dura and arachnoid to fragment of bone found between the dura and calvarium; removal of same with excision of dura over affected area; cortex beneath excavated and filled with a cystic mass; excision of all this. Wound tamponed with iodoform gauze; secondary suture forty-eight hours later. Recovery. Intensity of tetanic cramps relieved for a time only; no improvement in intelligence.—"Archiv f. klin. Chir.," vol. xxxvi., p. 860.

42. Greenfield and Caird.—Patient with diagnosis of abscess in anterior part of left temporo-sphenoidal lobe. Operation; evacuation of two ounces of fœtid pus. Wound completely healed in eighteen days. Recovery complete.—Ed. note, "Brit. Med. Jour.," 1887, Feb. 5, p. 94.

43. Barker.—Male, aged thirty-three. Previous trouble in right middle ear, and epileptic attacks when young. In 1886, weakness and coldness in right leg; subsequently, severe headache; tenderness over mastoid and right occipital regions. January 23, 1887, two epileptic spasms within an hour; right side of body convulsed; subsequently, unsteady gait, staggering to the left, and contraction of right pupil. January 25th, mastoid trephined in usual way; no pus found. Later, became semi-comatose, with paresis of left arm, and right pupil dilated. Diagnosis: suppuration over or in arm and face centers of right side. February 3, 1887, operation. Trephine applied over fissure of Rolando; dura bulging; serum found at depth of an inch and a quarter; when an inch and a quarter behind external meatus, pus found at considerable depth, and nearly half an ounce removed; abscess cavity drained by rubber tube, after which as much more pus escaped. Serious collapse of patient; reaction finally established. Patient soon convalesced, made nearly complete recovery.—"Brit. Med. Jour.," April 14, 1888, p. 777.

44. Birdsall and Weir.—Male, aged forty-two. Paretic symptoms in

limbs of right side, with diplopia, nausea, headache, etc.; later, hemianopsia and neuro-retinitis. Diagnosis of tumor in cuneus. This diagnosis was fortified by further observation, and symptoms of inco-ordination explained by its pressure on the cerebellum. Operation, March 9, 1887, by Dr. Weir. On opening skull, dura did not pulsate, but was of dark color; incision; appearance of tumor of reddish color, covered with vascular connective tissue; enucleation of same after its incision, and removal in two parts; hæmorrhage troublesome. Tumor found to be spindle-celled sarcoma; greatest circumference, eight inches and a half; weight 140 grammes. Five hours later, patient in collapse from secondary hæmorrhage; infusion of salt solution; bleeding continued. Death nine hours after operation.—"Med. News," April 16, 1887, p. 423.

45. G. **Hammond.**—Woman, aged thirty-two. First sign of trouble two years and a half previous. Began with loss of consciousness, left-side convulsions, paralysis of left side of face, left hand, arm, then leg; no sensory disturbance. Operation, March 30, 1887, by Roberts. Opening, exploratory puncture, and incision of brain; nothing found; dura wound closed by suture. She remained unconscious, and died in twenty-four hours. Autopsy showed three cysts deep in the brain-substance; their fluid was serous, containing broken-down brain-substance. They were close together, and in position to affect the face and arm and leg centers.—"Med. News," April 23, 1887, p. 472.

46. R. **Park.**—Male, aged twenty. In 1885 stabbed with knife at middle of left parietal eminence. Paresis of right arm followed for a few weeks. Recovery of the wound with suppuration. Six months later, first epileptic attack. Of late, fits at frequent intervals, aura beginning with spasms in left side of face and left angle of mouth; depressed scar nearly over the right arm center, not low enough for that of speech. Diagnosis of hæmorrhagic cyst, involving centers for arm and hand and face. Operation, March 31, 1887. Rectangular piece of bone removed with chisel; depression of inner table; dura adherent to bone above and beneath; cortex bound to the bone by adhesions. These were all loosened and the dura excised. Exploration revealed nothing further. Speedy healing of wound. Four months later was perfectly well and free from fits. Reported for first time.

47. **Bullard** and **Bradford.**—Boy, four and a half years old, who was delivered by the forceps, and had over the right parietal bone a scar and a depression supposed to have been caused by them. There had been no convulsions. He presented much diminished intelligence, inability to speak or to use any of his limbs well, with right internal strabismus and right spastic hemiplegia, in addition to the well-marked cicatrix. Operation, June 27, 1887, by Bradford. Trephining on the right side of the head directly over the cicatrix. It was determined that the outer portion of the bone had been fractured and the inner table fissured. The dura, which was thickened and vascular, was incised, but no lesion of the brain beneath was detected. The trephine was then applied over the motor area on the left side, over the junction of the middle and lower thirds of the fissure of Rolando. Here there had been detected a very slight superficial scar in the skull. After the disc of bone had been removed a depression of the brain substance was exposed. This was considered a parencephalic cavity. The patient's condi-

tion was so poor after this had been detected that the wound was speedily closed. He died seventeen days after the operation; no autopsy was permitted.—"Boston Med. and Surg. Jour.," 1888, cxviii., p. 162.

48. **BIRDSELL, AMIDON, and WEIR.**—Female, aged twenty-six. Had had four operations for sarcoma of neck. During the last operation the left brachial plexus was injured and paralysis of left arm followed for two months. Precipitate micturition and defecation; then cramps in left leg and paresis of same; later, cramps and numbness in right hand; for three weeks intense headache. Operation, August 11, 1887, by Weir. Tumor supposed to be in upper portion of Rolandic fissure; large opening made; dura tense and bulging. After incision of dura, brain bulged in wound. Nothing was felt under the finger, no resistance to needle upon pressure. A portion of protruding brain was sliced off, but nothing discovered. Bleeding profuse; checked by thermo-cautery. One week later, hernia cerebri, which developed to the size of a hen's egg. No reaction, but death two months and a half after operation, with signs of lesion in medulla. On autopsy, a tumor was found springing from left lobe of cerebellum; the medulla crowded to right and forward; the tumor extending down spinal canal found to be a spindle-cell sarcoma.—"Med. News," March 5, 1887, p. 273.

49. **SUCKLING.**—Girl, aged twelve years. Symptoms of two years' duration; vomiting, vertigo, inco-ordination, paresis of left facial muscles, closure of left eye impeded; tongue points toward the right. Diagnosis of tumor in left side of cerebellum, covering left side pons and left facial and abducent nerves. Operation, summer of 1887. Trephining of occipital bone so as to enter cranial cavity below transverse sinus. Dura exposed and divided transversely; cerebellum seemed soft; removal of considerable of its substance; free hæmorrhage; drainage-tube inserted and wound closed. Patient comatose for twenty hours and died in forty-eight. Autopsy showed degeneration, probably tubercular, of entire left lobe of cerebellum.—"Brit. Med. Jour.," Nov. 7, 1886, p. 870.

50. **OLIVER.**—Boy, aged sixteen, suffering from epilepsy. Nine months previously, concussion of brain; well for ten days; then had his first convulsive shiver, and became unconscious for a time. On recovery, severe headache in right side. From that day several fits daily, disposition altered; pain and tenderness referred to right temporal region; left arm and leg much more convulsed than right. During fits had occasionally choreiform movements of these limbs; stupor after the fits. Patient would lie speechless and deaf. Operation, 1887, by Hume. Opening made beneath the tender area. After incision into dura there was an escape of nearly an ounce of serum. Dural wound drained. During the next twenty-four hours there was a free escape of serum. Patient had a few fits during ensuing days, then rapidly recovered. Was free from fits for six months, then they recurred but were changed in character; were treated as hysterical, and after rest in bed he completely recovered.—"Brit. Med. Jour.," Feb. 4, 1888.

51. **SEGUIN and WEIR.**—Man, aged thirty-nine. Spasms of right side and neck. In 1886 fell unconscious one day; epileptic attacks preceded by aura in right hand and arm and right side of face. Diagnosis of tumor in left motor area. Operation, November 17, 1887, by Weir. Dura protruded slightly; appeared normal; extensively incised; brain seemed to protrude;

yielded deep resistence on palpation. Tumor size of an almond, discovered at depth of an inch, not encapsulated, apparently infiltrating surrounding brain tissue. It was lifted out with a Volkmann spoon. A small fragment, which had separated in process of loosening, was also separately removed. No hæmorrhage from brain ; wound drained and irrigated ; discs of bone with several fragments replaced over the dura. Tumor found to be sarcoma, principally of round cells. Patient recovered ; several months later was in good general condition ; better as regards paresis of face and hands : speech much improved. Five months later, no recurrence of growth. —"Am. Jour. of the Med. Sciences," July, 1888, p. 225.

52. Horsley and Ferrier.—Man, aged forty-seven. Offensive discharge from left ear. When seen was drowsy ; had pain over left side of head and back of eyes ; photophobia ; slight discharge from left ear. Became worse ; showed affection of speech ; used wrong words and so forth. Diagnosis of cerebral abscess in anterior third of temporo-sphenoidal lobe. Operation, December 10, 1887, by Horsley. Five drachms of pus evacuated. Complete recovery.—"Brit. Med. Jour.," March 10 and 24, 1888.

53. Keen.—Male, aged twenty-six. Fell from a window when three years old, his head striking on a brick. A superficial wound was made, and no trouble was experienced until he was twenty-three, when epilepsy developed, associated with aphasia and paralysis of the right arm and leg. Later, there was recovery from much of this disturbance. Operation, December 15, 1887. Keen removed a considerable area of bone and uncovered a tumor nearly three inches in length in its long axis. During the operation great trouble was experienced from hæmorrhage, which was checked partly by hot water. Patient did well. For several hours on the third day symptoms of brain pressure were observed, and this was attributed to the presence of a large clot of greater size than the original tumor. This was removed by careful washing, and all went well for ten days ; then pressure symptoms were again observed. There was also severe diarrhœa and a temperature of 104·5°. The presence of pus was suspected and the wound reopened. No pus was found, and a certain amount of hernia cerebri supervened. It was inferred that the unfavorable symptoms were largely due to the diarrhœa. and two or three other similar attacks made this still more apparent. The hernia was finally overcome, partly by skin-grafting. The wound was drained by bichloride gauze for eight weeks. It healed perfectly, but with a concave shape instead of convex, and has since continued to be depressed. —"Med. News," April 21, 1888, p. 107.

54. Harrison.—Boy, aged fifteen. Severe pain in head following a blow on right side of same eight days previously. Three days later, convulsions in right side of body, first in arm, then in face, then in leg. When they ceased, paralysis of these parts took place. A cicatrix was observed on left side of head covering an uneven surface of bone. It was then learned that eleven years previously he had received a severe blow on this side, causing compound fracture. During the last twelve months twitchings had been noted in the right arm. Diagnosis : abscess of brain in left motor region of cortex. Operation, December 23, 1887. Scar found to correspond to upper part of left ascending frontal convolution. Its center was made the center of the bone wound. The dura was found adherent to the bone with a ridge

of bone pressing abnormally on the brain; more bone was removed for the purpose of removing entire ridge; no bulging of dura mater; wound closed. December 27th, condition not improved. Wound reopened, dura incised, opening made to depth of an inch and a quarter, and pus was found. A free incision was made and four drachms of fœtid pus evacuated. Abscess cavity washed out and drained; subsequent complete recovery. Abscess rather than tumor diagnosticated because of history of original injury with latent symptoms followed by acute and accelerated by recent blow.—"Brit. Med. Jour.," April 21, 1888, p. 848.

55. STOKES reported a case of successful trephining for cerebral abscess, and exhibited the patient. The man had been struck with a poker on the left side of the mesial line of the head, and about an inch anterior to the coronal suture. He was admitted to the hospital, several weeks having elapsed from the date of the injury. He soon presented brain symptoms, became convulsed and comatose, and it was determined to trephine. Operation, 1887. A small fracture was found under the scar, the dura bulging into the wound; and an exploring needle was introduced to the depth of an inch and a half, and pus was at last found. The dura mater was then incised and an ounce and a half of pus was evacuated. The patient completely recovered and is now attending to his ordinary work.—"Brit. Med. Jour.," March 3, 1888.

56. MACEWEN.—Male, aged forty-five. Injury to parieto-temporal region of skull some months before. Hemiplegia almost immediate persistent. January, 1886, trephining over fissure of Rolando over center for lower extremity. Dura tense and pulsating, incised, and several ounces of clear fluid escaped. Subdural cyst lined with brownish membrane. Sharp fragment of bone projecting into brain removed; cyst cavity scraped out, and counter-opening made for better drainage; bone disc reimplanted. Complete cure.—Senn's "Four Months among the Surgeons of Europe."

57. DRUMMOND.—Patient of unknown age. Headache in left temporal region; optic neuritis; cramps beginning in right eyelid, involving right leg, then left side of face and left arm; finally paralysis of right side and spastic rigidity of left side; motor aphasia. Operation, 1887. Bone removed over facial center; opening made; nothing abnormal discovered. Several days later, delirium and death. Abscess found in posterior part of frontal convolution.—"Lancet," October, 1887, p. 656.

58. CECI.—Male, aged fifty-two. Blow on temple, with depression. Two months later, hemiplegia and loss of sphincter, control of bladder, with stupor. Operation, 1887. Dura adherent to bone and thickened; underneath adhering to a clot; some of the blood still fluid; no pus. Almost complete recovery.—Congress of Italian Surgeons, 1888.

59. FILKIN.—Girl, aged seventeen. Fracture of skull when ten months old. Right arm and leg almost completely paralyzed and ill developed. Temperature 2° lower on left side. Operation, January, 1888, over motor area. A large cyst extending to depth of two inches from surface; also an osteophytic growth extending half an inch below level of surrounding bone. Rapid healing; great improvement in motility.—"Edinburgh Med. Jour.," 1888.

60. KEEN.—Man, twenty-five years old. History of fall eighteen months

previously. Depression two inches long on right side of head, over supramarginal and post-Rolandic convolutions; paralysis of left wrist and hand; four epileptic fits. Operation, April 12, 1888. Opening three inches and a quarter by an inch and a half; excision of underlying dura which had attached to its under surface a small fragment of bone. Brain tissue found diseased throughout length of scar, and in posterior end of latter a small cyst. Removal of all diseased brain tissue. Patient out of bed on fifth day. Ergot given instead of morphine, and cocaine applied locally as a hæmostatic with good results. Button of bone removed was sewed to under surface of scalp flap by catgut ligature passed through two apertures made in the bone for that purpose.—"Med. News," April 21, 1888, p. 438.

61. KEEN.—Man, twenty years of age. Suffered from epilepsy for seven years; cause obscure. Attacks all began in left hand. Diagnosis of lesion in center for left hand toward inferior extremity of post-Rolandic convolution. Operation, May, 1888. Opening made in skull two inches and a quarter by two inches and a half. It was difficult to decide which was the post-Rolandic convolution. By use of faradaic current the hand center was determined to lie in the anterior of the three gyri, and this portion was accordingly excised. Replacement of trephine button with a number of smaller fragments. Wound drained. Temperature never reached 100°. On the eighth day patient was out of the house. Integrity of skull entirely re-established. The left has since been paralyzed, but no other paralysis has ensued. Epileptic spasms at first increased in number, but have since diminished in frequency and severity.—"Med. News," June 15, 1888, p. 672; "Am. Jour. of the Med. Sci.," Oct., 1888; also personal communication.

62. MILLS and STEINBACH.—Male, aged thirty-five. Blow on head twenty-nine years previously; epilepsy ever since; convulsive movements in left leg and arm, less on right side; depression of bone over left Rolandic fissure. Diagnosis of lesion in the brain at this point. Operation, July 18, 1888. Trephining over this area. A cicatrix found in dura; excision of same.

63. LLOYD and DEAVER.—Blow on head at fifteen; unconscious and bedridden for a week. First fit at twenty-one years of age. Fits both nocturnal and diurnal, gradually increasing in frequency. While in the hospital has had as many as twenty-eight in one day. Aura from fore and middle fingers of left hand. Fit begins in forefinger of left hand, involving especially (and sometimes only) muscles of left arm and left face. Left arm and left face (especially) paretic during intervals between fits. Loss of consciousness in these slight seizures little if any. Has occasional greater fits, spreading very generally over body on both sides, but always worse on left side. No aphasia. No ocular symptoms. Little headache. No gastric symptoms. Operation, June 12, 1888, by Deaver. No gross lesion discoverable in bone, membranes, cortex, or subcortex. Motor centres for arm and face mapped out with faradism by Dr. Lloyd and carefully excised. Antiseptics. After operation, slight twitching occasionally in left hand and face for six days, maniacal delirium, with visual and auditory hallucinations. Recovery. No convulsion since. Paresis of left face and flexor muscles of finger and thumb continues.—Personal communication.

NOTE.—I desire to express here my obligation to Professor Mills for assistance in the collection of these cases, and to Professor Keen and Dr. Deaver for personal accounts of their own cases.

No.	Operator.	Year.	Nature of case.	Result.	Remarks.
1	Macewen.	1879.	Degenerated clot.	Recovery.	
2	Stimson.	1880.	Abscess of parietal lobe.	Death after 9 hours.	
3	Macewen.	1881.	Abscess in temporo-sphenoidal lobe.	Death.	Patient *in extremis* at time of operation.
4	"	1883 (?).	Hæmorrhagic lesion in ascending frontal convolution.	Recovery.	
5	"	(?)	Subdural syst and depressed fragment of bone.	"	
6	"	(?)	Abscess of temporo-sphenoidal lobe.	"	
7	Wernicke and Hahn.	1881.	Abscess in occipital lobe.	Death in 6 days.	Perforation into ventricle found.
8	Polaillon.	-----	Subcortical abscess.	Death in 6 days.	
9	Macewen.	1883.	Tubercular meningeal lesion.	Recovery.	Bergmann considers this to be gumma.
10	"	"	Inflammatory and cystic degeneration.	"	
11	"	-----	Dural tumor over ascending frontal e.	"	
12	"	-----	Cyst in ascending frontal convolution.	"	
13	"	-----	Tuberculosis. Nodule in cortex.	"	
14	"	-----	Depression of inner table over angular gyrus.	"	
15	Leo.	1882.	Depressed bone.	"	
16	Durante.	1884.	Sarcoma of frontal lobe.	"	
17	Bennett and Godlee.	"	Glioma.	Death after 4 weeks.	
18	Mills and Hearn.	"	Meningeal adhesions,	Death in 80 hours.	From pachymeningitis.
19	Gussenbaur.	1884,(?).	Abscess, subcortical.	Recovery.	
20	Truckenbrod.	1885.	Abscess, subdural.	"	
21	Hirschfelder & Morse	1886.	Glioma in motor area.	Death.	
22	R. Park.	"	Subdural cyst in motor area.	Recovery.	
23	Horsley.	"	Cicatrix near upper end of sup. frontal sulcus.	"	
24	"	"	Tuberculous tumor in motor area.	"	
25	Bergmann.	"	Abscess beneath motor area.	Death.	Temporary improvement. On autopsy another abscess found.
26	Horsley.	"	Traumatic cyst and depressed bone.	Recovery.	
27	Hulke.	"	Abscess in cerebellum.	Death in 24 hours.	
28	Bennett and Gould.	"	No internal lesion discovered.	Recovery.	Operation for epilepsy. Cured.
29	Horsley.	"	Glioma, weighing 4½ ounces.	"	Death 6 months later from return.
30	"	"	Irritative lesion in facial center.	"	
31	"	"	Subdural cyst and cicatricial lesion.	"	
32	R. Park.	"	Cyst involving speech and arm-centers.	"	Slight improvement in paretic condition.
33	Horsley.	"	Irritative lesion of dura and bone.	"	
34	May.	"	Tuberculous tumor of cerebellum.	Death same day.	No autopsy.
35	Heath.	"	Tumor fixed to base of anterior fossa.	Operat'n abandoned.	Recovery from what was done.
36	Horsley.	"	Cyst suspected; no lesion found.	Recovery.	Complete relief of symptoms.
37	"	"	Tumor in motor area of 4½ oz. weight.	"	
38	Bergmann.	"	Sarcoma "size of small apple."	Death on 5th day.	Œdema of Brain.
39	Horsley.	"	Tuberculous mass 7 drachms in weight.	Death.	Disseminated tuberculosis.
40	Markoe.	1887.	Lesion of uncertain and anomalous nature.	Recovery.	
41	Bergmann.	"	Depressed bone and dural cicatricial lesion.	"	No improvement in symptoms.
42	Greenfield and Caird.	"	Abscess in temporo-sphenoidal lobe.	"	
43	Barker.	"	Abscess in temporo-sphenoidal lobe.	"	
44	Birdsall and Weir.	"	Sarcoma of occipital lobe.	Death in 9 hours.	Uncontrollable hemorrhage.
45	Hammond & Roberts.	"	Deep, subcortical cysts.	Death in 24 hours.	Cysts not found till the autopsy.
46	R. Park.	"	Cicatricial dural lesion of arm-center.	Recovery.	
47	Bullard and Bradford	"	Dural and porencephalic lesion.	Death on 17th day.	No autopsy.
48	Birdsall, Amidon, and Weir.	"	Sarcoma of left lobe of cerebellum.	Recovery.	Death in 10 weeks. Tumor not discovered till autopsy.
49	Suckling.	"	Degeneration of left lobe of cerebellum.	Death in 48 hours.	Probably tuberculous.
50	Oliver and Hume.	"	Cystic lesion.	Recovery.	
51	Seguin and Weir.	"	Sarcoma in motor area.	"	Nine months later no return.
52	Horsley.	"	Abscess in temporo-sphenoidal lobe.	"	
53	Keen.	"	Tumor in motor area, "3 inches long."	"	Recovery retarded by hernia cerebri and other complications.
54	Harrison.	"	Subcortical abscess.	"	
55	Stokes.	1887 (?).	Subcortical abscess.	"	
56	Macewen.	1887 (?).	Subdural cyst, with depressed spicule of bone.	"	
57	Drummond.	1887.	Abscess of frontal convolution.	Death.	Lesion not discovered till the autopsy.
58	Ceci.	"	Fluidified clot (cyst ?).	Recovery.	
59	Filkin.	"	Large and deep cyst, with osteophyte.	"	
60	Keen.	1888.	Dural (cicatricial) lesion, with degenerated cortex and a cyst.	"	
61	"	"	Irritative lesion in hand-center.	"	
62	Mills and Steinbach.	"	Depressed bone and cicatricial lesion in dura over motor area,	"	
63	Lloyd and Deavor.	"	Irritative dural and cortical lesion.	"	

DISCUSSION ON CEREBRAL LOCALIZATION.

APHASIA.

PAPER BY

DR. M. ALLEN STARR, OF NEW YORK.

It is evident from the statements to which we have just listened that cerebral surgery has achieved much and has a great future, but that it is largely dependent upon neurology. The surgeon is ready to proceed when the neurologist can indicate the way. The operator waits for the diagnostician.

The responsibility for further progress rests, therefore, with physicians. How is that responsibility to be met? There is no subject in the domain [of medical science which enforces more strongly the necessity of following closely the inductive method of reasoning than this one of cerebral localization. The conclusions thus far arrived at have been reached by the collection and analysis of facts. Physiology had, it is true, shown the way; it had led up to an hypothesis regarding cerebral action in man. But the conclusions on which we rely have been derived almost wholly from the comparison of large numbers of clinical cases, supplemented by pathological records. And every decided advance in the knowledge of the localization of functions has been due to the careful collation of cases with autopsies and the study of their common features. I need only refer to the classical work of Nothnagel,* the collections of facts made by Charcot,† Wernicke‡ and others, and the recent study of hemianopsia by Seguin§ for proof of this assertion.

The experience of the past must be our guide in future. If advances are to be made it must still be along the line of induction. But induction rests primarily on the careful study of individual cases. It seems perhaps superfluous to state this fact, or to urge the necessity of recording and publishing every valuable case of cerebral disease. Yet it cannot be denied that much valuable material is unused in this country. Surely our opportunities of observation are equal to those abroad. But our medical literature is not equally rich in the careful records of cases. We are too impatient of detail; too eager for general results. If we are to aid in advancing the knowledge of cerebral localization it is by appreciating the fact here urged that *every* case has a positive value and should be made common property. And each case, too, must be properly examined in order to yield all the facts which it contains. This is especially true of the class of cases which has been assigned to me for discussion, viz: the cases presenting disturbances of speech.

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* Nothnagel, Topische Diagnostik der Gehirnkrankheiten.

† Charcot et Pitres, Localizations des Funct. Cereb. Rev. de Med., 1883.

‡ Wernicke, Lehrbuch d. Gehirnkrankheiten I.

§ Seguin, Hemianopsia, Jour. of Ment. and Nerv. Disease, 1887.

If time would permit it would be an interesting study to trace the gradual growth of clinical and pathological facts regarding disturbances of speech and their important bearing upon the theory of localization of cerebral functions. It is only possible here to notice the most striking.

There have been three epochs in the history of aphasia, each of which has been marked by a decided advance in knowledge. In the first—*the Epoch of Broca,* 1864 to 1874—the claim of Broca that lesions of the posterior portion of the third frontal convolution on the left side produce a loss of speech was established upon an impregnable basis. It is true that the discussions of the French Academy and the observations of those hostile to the new doctrine resulted in proving that loss of speech might be caused by lesions elsewhere in the brain. The necessity of distinguishing between right and left handed persons was also brought out, with the remarkable fact that while Broca's statement was true of right handed persons, in left handed people the speech centre lies in the right hemisphere, a rule to which there are few exceptions.*(2) And finally it became evident that the form of loss of speech produced by lesion in Broca's centre was not associated with the loss of memory of words.

In the second epoch—*the Epoch of Wernicke,*† from 1874 to 1883—a broad distinction was drawn between motor and sensory aphasia. This distinction had been observed clinically by English observers,‡ but Wernicke first showed its pathological basis. Motor aphasia was shown to be a loss of speech due to a defect in the process of articulation, the proper combination of movements of lips and tongue being no longer possible—not because of paralysis in the muscles—but because those memories of efforts necessary to produce words, acquired by practice, had suddenly been lost. This form of aphasia was shown to be the form observed by Broca and produced by lesion in his centre. Sensory aphasia, on the other hand, was shown to belong to the perceptive rather than to the emissive elements of speech and to be characterized by a loss of memory of the sound of words, so that they could no longer be called to mind or recognized when heard. This form of aphasia Wernicke concluded, from a few cases, was traceable to a lesion of the first temporal convolution in its posterior two-thirds. And this distinction, soon after confirmed by Kussmaul* in his classical work, formed the second great advance in the knowledge of aphasia.

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* (2) Paget, Brit. Med. Jour., Dec. 27, 1887.

† Wernichc, Die Aphatische Symptomem complex, 1874.

‡ Ogle, St. Geo. Hosp. Rep., 1867. Barteau, Brit. and Foreign Med. Chir. Rev., 1869. Broadbent, Medico Chirurg. Trans., 1872.

The third and present epoch is *the epoch of Charcot.*† Charcot with his sharp clinical insight and masterly power of analysis saw that further distinctions were possible. Before the use of language comes observation by the senses and the retention in memory of the things observed. Language is both spoken and written. Hence in its acquisition two kinds of sensory memories, auditory and visual, must be obtained. But given that store the individual must put it to use. He can do so in speech and in writing, each of which acts involves a separate kind of effort calling into play separate sets of muscles. These acts are acquired by practice. Practice means the repetition of a certain effort until its memory is fixed in the mind, and thus for the expression of language two efforts or motor memories are required, each of which is distinct. Charcot says, "A word is a complexus; in it one can discover, at least in persons of education, four distinct elements; the auditory memory picture, by whose means we are able to grasp the sense of words heard; the visual memory picture, which enables us to comprehend the words written or printed; and also two motor elements, that is to say, the motor memory of articulation and the motor memory of writing; the first developed by the repetition of movements of the tongue and lips necessary to pronounce a word; the second by the practice of motions of the hand and fingers necessary for writing." These memories, which Charcot distinguishes from one another, are joined together by processes of association and form the mental substratum of language. But since they are distinct each may be lost while the others remain. And hence four distinct forms of disturbance of speech will result.

The loss of the visual memories will result in visual amnesia and word blindness. This is a disease of readers. The loss of the auditory memories will result in auditory amnesia and word-deafness. The loss of the motor memories of writing and of pronunciation will produce agraphia and motor aphasia. But individuals differ widely from one another in the development of the various mental powers. Some can remember more easily things heard than things seen, e. g., names and not faces. Others have to write down anything which they wish to remember. In these different persons of different capacity aphasia will present somewhat different features. The man who depends on his memory of things heard will be more seriously affected by a disease which destroys his auditory memories than will be the man who depends on his visual memory. The scholar who constantly studies and the laborer who reads only the street-signs will be very differently effected by a lesion producing a loss of the visual memories. These distinctions of mental power therefore cannot be disregarded in the study of a disease which touches the physical basis of mind.

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* Kussmaul, Disturbances of Speech, Ziemssen's Cyclo., vol. xiv.

† Charcot, Leçons Progrès Médical, 1883. Ballet, La language interieur et des diverses forms, 1886. Bernard, De l'aphasie, 1885.

Another fact brought to light by the German school is the comparative independence of those memories which subserve language and those other memories which combine to make up the mental image or concept. Of every known object we have a congeries of separate memories, the residue of past perceptions, and these combine to form the idea of that object. The bell—to use Charcot's apt illustration—has a shape, a tone, a hard, cold, metallic feel, which can be recognized even though we cannot recall its name. These memories as well as those which go to make up the word bell may be lost. And then neither the sight, nor the sound, nor the touch of the bell will call up any notion to the mind. The use of the object perceived will not be known. And for this symptom the term *apraxia* has been coined by Kussmaul. *Apraxia* is the inability to recognize an object by the aid of any of the senses. It includes psychical blindness, the form most frequently discovered, and also psychical deafness. The independence of memories of sound from memories of words has recently been established by Oppenheim.* He found that many aphasics retain their musical faculty, and can recognize and appreciate melodies and music, when they have lost the power to understand language ; are able to sing a tune sometimes even with words when they cannot talk ; or can read and write notes when they cannot read and write words. Other aphasics lose these powers as well as those of speech, and then are psychically deaf to music.

Psychical blindness is quite frequently detected and occurs usually in conjunction with word-blindness. The patient then no longer recognizes his friends when he sees them, or knows what objects—such as food, clothing, and articles of daily use—are.

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* Oppenheim, Charité Annalen, vol xiii.

The clinical examination of an aphasic is incomplete unless the condition of each of these various kinds of memory pictures is determined. (See Appendix 1).

If we turn now from these clinical distinctions, each of which has been abundantly proven by the records of cases carefully studied, to the pathology of these forms of aphasia. We find that while something is known much remains to be discovered. There is a consensus of opinion based upon a very large number of cases that motor aphasia is produced by a lesion of Broca's convolution—the posterior part of the third frontal convolution of the left hemisphere in right handed, and of the right hemisphere in left handed persons. It is not necessary to cite cases in this connection for the assertion is not disputed by any authority. When that centre is involved, motor aphasia results. But Broca's centre is connected with the cranial nerve nuclei by a nerve tract which transmits the impulses that start the speech mechanisms. And lesions in this tract appear to cause as true a motor aphasia as lesions at its origin.* The differentiation between cortical and subcortical lesions meets us here at once. The only method of diagnosis is the study of collateral symptoms accompanying the aphasia, and the study of the history of the case which may settle the nature of the lesion and thus aid its localization. If that lesion is just beneath the cortex it cannot be distinguished from a lesion of the cortex. If it is in the speech tract as far from the cortex as the internal capsule where it will not injure the commissural fibres between the two frontal lobes the aphasia will only be temporary; the impulses are there supposed to cross from Broca's center to the other hemisphere and thence go down to the nuclei.† And in this case other symptoms of capsular or basilar lesion will be present to indicate the site of disease. This distinction is important, for while Broca's centre is easily accessible to the surgeon—as one of Macewen's cases proves—the time has not yet come when he can reach the internal capsule.

The situation of the lesion causing agraphia is not known. The frequency with which this symptom occurs with motor aphasia has led to the supposition that they always coincide. In the uneducated, as in children, the act of writing is often accompanied by an inward whisper, which may even amount to a movement of the lips. In such persons speech and writing are closely connected and are usually lost together. But cases of agraphia without aphasia* prove that these acts are independent. The hypothesis is natural that the writing centre is near the motor centres for the hand; but whether it lies in front or behind these is not determined. As future observation must settle this question it may be well to call attention to the fact that there are varieties of agraphia. The loss of recollection of how words look, a mild form of word blindness, will prevent a person from writing spontaneously and thus produce sensory agraphia. But in true agraphia the pen cannot be used at all, and copying or writing at dictation are lost as well as the power of voluntary writing. Each of these acts should therefore be tested in any case.

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* Raymond et Artaud, Gaz. Med. de Paris, 1883, No. 47. Arch. de Neurol., No. 20, 1883.

† Gowers, Diseases of the Nervous System, vol. ii., p. 106.

The situation of the lesion producing word-deafness with amnesic aphasia is now well known. And yet a careful search through American and foreign literature has enabled me to find only about thirty-five cases of word-deafness with autopsies which are above hostile criticism. In all of these Broca's centre was unaffected.

These cases are tabulated on the diagram, which is similar to one used by Naunyn a year ago at the German Medical Congress at Wiesbaden. My collection of cases of word-deafness is about double that of Naunyn, he having included motor aphasia in his collection. The cases are numbered from ten to fifty-four, ten cases of word-blindness being included in this collection, the numbers one to nine being omitted because inconspicuous. The diagram is prepared as follows: The lateral surface of the brain, as shown by Ecker, has been divided into squares. When, in a given case, the area indicated by one of these squares was invaded by disease, the number of that case was put down in the square. The great preponderance of numbers in the temporal and lower parietal regions shows that this is the seat of the lesion in the large majority of the cases of sensory aphasia.

Some of the cases presented extensive lesions outside of the speech area (e. g., cases 42 and 48) as well as in it, but in none was Broca's center destroyed or invaded by disease. Others were entirely confined to the temporal or parietal convolutions. The character of the aphasia was in all sensory. In many cases word-deafness occurred alone not associated with word-blindness and in these the temporal convolutions only were involved. In some cases word-blindness occurred alone, not associated with word-deafness, and in these the lower parietal lobule including the supra marginal and angular gyri only were involved. In a third class both word-deafness and word-blindness occurred together and in these both areas were invaded by the lesion.

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* Cases of pure agraphia are recorded by Pitres, Rev. de Med., 1884, p. 865. Ogle, St. George's Hosp. Rep., 1867, Obs. iii. Marie, Progrès Médical, 1888, No. 5.

It is impossible to make any pathological distinction as yet between mere loss of power to recall words and the severer condition in which words are no longer recognized and are mispronounced. It has been thought that the lighter form was due to superficial cortical disease and the severer to a deep lesion, but the records point rather to a lateral extent of disease as determining its severity. It may be that an inability to recall words implies a partial disturbance of association fibres going to the temporal region, while loss of power to recognize words implies a total destruction of the fibres and cells. Grashey indeed has advanced the opinion* that the mere failure of recollection is a functional difficulty not necessarily accompanied by organic change and due rather to inability to fix the attention, and the question is still open. In any case of true word-deafness the possibility of surgical interference, where the nature of the lesion allows it, is admitted, for the temporal lobe is easily reached by the trephine, and a large opening will expose the posterior half of both temporal gyri.

The situation of the lesion producing word-blindness is also indicated in the diagram. Eleven cases of pure word-blindness have now been recorded with autopsies.† In all of these the disease was situated in the angular gyrus and supra-marginal convolution. In many cases of word deafness the lesion involved this region also, and in these word-blindness was also present. The patients were then unable to read printed or written language, to recall the appearance of words or to write spontaneously.

While the number of recorded cases is small they certainly are sufficient to warrant surgical interference in this region if the case requires. This is especially true if word-blindness is attended by that form of the symptom "*apraxia*" known as psychical blindness already described. For in the nine cases with autopsies in which this has been noticed the lesion has always been found in the angular gyrus or just beneath it in the association tracts between temporal and occipital lobes.‡ And only last month a successful case of trephining over this gyrus was reported by Macewen of Glasgow, where the only guide to the localization of the disease was a condition of word blindness with psychical blindness which had developed for a short time after an injury occurring one year before the operation. The probable cause of psychical blindness, in all cases of local lesion is the division of association tracts beneath the cortex. Subcortical lesions here often cause hemianopsia. This is so clearly proven by the autopsies as to warrant an exploratory incision into the white matter under the angular gyrus in any case of word-blindness with psychical blindness and hemianopsia where the gyrus itself does not appear to be diseased when exposed to view by the surgeon.

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* Grashey, Arch. of Psych., xvi., Uber aphasie.

† Cases No. 10, 11, 21, 29, 32, 45, 48, 50, 51, 52, 54.

‡ Cases No. 10, 25, 29, 37, 39, 42, 51, 53, 54.

Is it possible to detect other lesions affecting the association tracts beneath the cortex? In all speech processes an association of various memory-pictures is constantly going on. Thus the act of repeating a word after another calls into play the tract which joins the word-hearing and the word-uttering areas, a tract which passes beneath the Island of Reil.* A lesion in this tract prevents the act of repetition and results in the patient's talking jargon. Such acts as copying, reading aloud, and writing at dictation, involve functional activity in two centres and in their connecting fibres, and hence should always be tested in examining cases. Lichtheim in an article of great ingenuity† has attempted to show that different clinical forms of aphasia exist for each break in these association tracts; and it seems probable that in the next epoch of aphasia many new varieties will be distinguished and new lesions localized. It is not yet possible, however, to make statements of sufficient definiteness to warrant a practical application in surgical procedure.

A case of pure aphasia of one of the varieties here set forth is a rarity. The majority of cases met with in practice are really cases of mixed aphasia in which both motor and sensory defects are combined. This is the experience of all recent observers. It does not, however, detract from the value of the observations and distinctions here recorded. For they are valid. Nor does it prevent the surgeon from proceeding when the nature of the lesion will allow. For that lesion is in the Sylvian region in any case and the preponderance of either motor or sensory symptoms will lead him to place his trephine respectively further anteriorly or posteriorly. Cases might be cited of fractures of the skull or perforating wounds in which this Sylvian region has been injured and aphasia produced. Lohmeyer‡ in 1872 was able to find fifty-three such cases and recent surgical literature is full of them.§ But where a surgeon has an external injury to guide him he needs no help from the neurologist. It is in cases of internal disease that indications are sought from brain symptoms. And certainly the recent advances in the knowledge of aphasia give us indications sufficiently definite to be of practical use. For though we have to admit several speech areas instead of one speech center, there is no reason why motor, or sensory, or mixed aphasia should not be taken as guides to operation as reliable and satisfactory as monospasm or hemianopsia.

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* See case 13, also Starr, Cortical Lesions. Am. Jour. Med. Sci., 1884. Case 99.

† Lichtheim, Brain, 1885.

‡ Lohmeyer, Arch. fur Klin. Chirurg., xiii.

§ Turner, Lancet, 1887, No. 3 with references, and Singer, Prager, Medic. Wochenschr. 1887, No. 6.

APPENDIX I.

To examine an aphasic thoroughly it is necessary to test:

1. Power to recall the name of objects, (a) seen, (b) heard, (c) felt, (d) tasted, (e) smelt.
2. Power to understand speech—musical tunes—figures.
3. Power to understand gestures.
4. Power to understand printed or written words.
5. Power to speak voluntarily. Does he talk clearly? Does he misplace words? Does he mispronounce words? Does he talk jargon?
6. Power to repeat a word after another.
7. Power to read aloud. Does he understand words read aloud?
8. Power to write voluntarily. Can he read what he has written?
9. Power to write at dictation.
10. Power to copy.
11. Power to recognize the use of objects seen, heard, felt, tasted, or smelt.

For explanation of the Table and Diagram, see page 354.

Dr. David Ferrier of London.

I have listened, as I am sure all present have done, with the greatest pleasure and profit, to the excellent papers read before us by Dr. Mills and Dr. Park, in which they have so lucidly expounded the doctrines of cerebral localization, and the principles of cerebral surgery. I take,—if I may venture to say so,—a peculiar pride in the fact that the question of the practical application of cerebral localization has had assigned to it such an important place in this great gathering of the profession of this country. For it has long been a cherished idea with me—long, before to my knowledge, it had assumed definite shape or practical realization—that the methods of physiological experiment on the lower animals, and the accurate determination of the functions of the brain, would one day lead to the successful treatment, by surgery, of some of the most distressing ailments to which our fellow creatures are subject.

Our experiments had demonstrated the entire freedom from risk of operations on the skull and brain under antiseptic precautions, and the almost perfect safety given life, of even the most formidable lesions and complete removal of large portions of the cerebral substance. It seemed but a slight step, and not a rash one, to venture on the brain of man himself. But I received little encouragement, when, on more than one occasion, I ventured to suggest to some of my surgical friends the advisability of operating in certain cases under my care—patients who if they had lived to see this day would, I doubt not, have lived to see many more. I was told in effect that men were not monkeys, though they might be descended from them, and that what could be done in the green tree could not perhaps be done in the dry.

When five years ago, at a meeting of the Medico-Chirurgical Society of London, I ventured boldly to advocate the surgical treatment of cerebral tumors and the like, I incurred the condemnation of the Lancet in a leading article, the words of which I made a careful note of, as I was persuaded they would one day come in useful. That day has already arrived, and here are the words: "It is somewhat humiliating that so great an increase in one branch of diagnosis should be of little practical avail for therapeutic purposes, but this need not lessen the satisfaction of those whose labors have added to our knowledge, since it is true also of other branches of diagnosis. That it must be confessed that the aid 'localization' has afforded to treatment has been small, and practically confined to cases of surgical interference. Even of these cases there are few—scarcely more than could be counted on the fingers of one hand—in which the power of localizing cerebral disease can be said to have been the means of saving a life that would have been lost without it. Nor is any clear indication to be seen that such cases are likely to be more frequent. Very few will share Dr. Ferrier's confident anticipation that the history of abdominal surgery is likely to find a parallel in surgical achievements within the cranial cavity, in spite of the authority with which he cites his experience with the lower animals. The difference between the abdomen and the skull are more than even antiseptic surgery can annihilate. If Dr. Ferrier's suggestions meet with much practical response, it is to be feared that cerebral localization will soon have more deaths to answer for than lives to boast of."*

If we compare this estimate of the value and prospects of cerebral surgery with the magnificent successes achieved by Macewen, Horsley, Keen and others of your countrymen, I think that little doubt can be

* Lancet, Nov. 10, 1883.

entertained by any of you that cerebral surgery has amply vindicated its claim to take rank among the most beneficent applications of the surgical art. When we think of the numerous cases of tumors removed and the victims saved from certain and painful death ; of abscesses accurately diagnosed and successfully evacuated ; and of epileptiform convulsions to all appearance forever stilled, and all by the aid of localization determined by physiological experiment and verified by clinical observation, apart from traumatic or surgical indications proper, it is no longer possible to say with truth that cerebral localization has been of little practical value for therapeutical purposes. It would be erroneous, however, to assume that success has always attended our efforts. Mistakes have been made in diagnosis, and deaths have resulted from other causes than septic inflammation. But this is no more than can be truly said of any great surgical operation ; and assuredly the number benefited has been vastly greater than those whom we have failed to cure or relieve. I confess, however, that I have been somewhat disappointed in the results of the surgical treatment of what is termed Jacksonian epilepsy, i. e., those cases in which epileptiform convulsions are caused by a local or irritative lesion in the opposite cerebral hemisphere. It was natural to suppose that removal of the focus of irritation would put an end to the convulsions by destroying the *pons et vigo mali.* But this happy result has not always ensued, probably from the fact of an epileptic habit being established in the nerve centres. And I would make this the ground of advocating surgical interference at the earliest possible time after the disease has clearly manifested itself.

We must be on our guard lest our new-born enthusiasm should lead us to rashness in operation, or to the infliction of greater evils than the affliction which we are endeavoring to remove. It would, to my mind, be a questionable cure if we could only stop an occasional attack of Jacksonian epilepsy by making the patient permanently hemiplegic, or depriving him forever of the faculty of speech. But who has a right to lay down rigid bounds beyond which cerebral surgery shall not pass, and who can venture to forecast all its developments? I myself believe, though I cannot define the grounds of my belief, that there are a host of cerebral affections, other than tumors, abscesses or irritative lesions, which may in time find the relief at the hands of the surgeon which they have failed hitherto to obtain from the physician.

Though our knowledge of the functions of the brain and of the principles of diagnosis of cerebral disease has made enormous strides of late years, and has rendered possible the brilliant surgical achievements of which we have heard this evening, we must not imagine that we really know much about the brain after all. Though we can point to the portion of the brain concerned with the movements of the foot, the head, the mouth, etc.; to that portion of the brain with which we see, or hear, or feel, and determine with a fair degree of accuracy the seat and kind of disease which invades the cerebral cortex, yet there are portions of the cortex which are to us still practically a *terra incognita.* And even with respect to the regions which I have alluded to there are still considerable differences of opinion, which though not materially affecting the diagnosis of coarse cerebral disease, are yet of no little importance in relation to a true conception of the mechanism of brain function. For behind those sensory and motor centres there lie also all those functions which constitute mental phenomena, a true correlation of which with their material substrata is even of greater importance, both theoretically and practically, than the mere determination of their physiological significence, and the effects of irritative and destructive lesions.

This is neither the time nor place for me to enter into detail of vexed questions, or expound my own particular views or speculations. They are in the main in accordance with what has been laid down by Dr. Mills. I will therefore not trespass longer on your attention, and more especially as there are to follow me many whom you will be anxious to hear. Among these is my distinguished colleague Mr. Horsley, who has done so much for cerebral surgery.

Let me, however, before sitting down, thank you most warmly for your cordial reception, and the attention with which you have favored me.

Mr. Victor A. H. Horsley, of London.

Mr. President and Gentlemen: In the course of what I have to say to-night, I shall have occasion to refer to numerous experiments. These experiments have been performed by myself in conjunction with other observers, and therefore when I refer to them inadvertently as my own work, I beg you to understand that I am simply the spokesman of my colleagues, Drs. Schäfer, Beevor, Gotch and Felix Semon. The subject which you have done me the honor to ask me to speak upon is so enormous, that at first I was in the greatest difficulty to know in what way I could be of any service to you. It occurred to me that I had better take up a distinct line and give you so far as I was aware, the latest facts that have come under my notice in that line. I shall therefore give you the facts only, and ask you to take on trust the observations on which those facts are based.

I shall not refer at all to cerebral localization of the so-called special senses, beyond possibly an allusion to the tactile sense, for several reasons, the greatest of which is absence of time. I shall confine my remarks entirely to that region which Prof. Ferrier was the first to map out, namely, the so-called motor region.

I believe that in this so-called motor region we have three functions clearly represented, and these I have placed upon the diagram before you. They are: 1. Slight representation of the tactile sensation, 2. Representation of the so-called "muscular sense," and 3. Great representation of movement. The evidence in favor of this belief is both, morphological and physiological. We must believe that these three functions are wrapped up closely together and that in every given particle of grey surface, there is represented this triune function for a single segment of the body. *Morphologically* we find that the large cells in the fourth layer are the seat of the representation of movement. I therefore can not understand why we should not give to the small cells of the upper layer, the representation of sensation. The *physiological* evidence on which this belief is founded is both, experimental and clinical, and as I have published my observations on this point at length, elsewhere, I may leave the question of sensory representation.

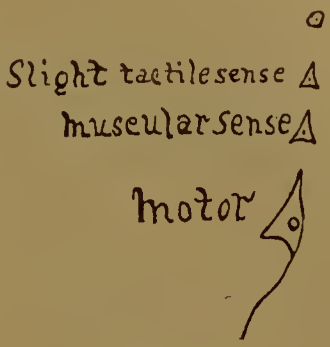

FIG. 11.

Passing now from the representation of tactile and muscular sense, I want to say a word or two upon the mode of representation of movement in this so-called motor cortex. It seems to me that we must consider this very closely if we are to gain an accurate and minute knowledge of the localization of representation of the different segments of the body. It will be obvious to you that in considering the representation of movement we have two factors under our notice, first the geographical or anatomical, and second the functional or the kind of movement represented. Professor Ferrier was the first to give an accurate map of the representation of the division of the body. He gave us the representation of the face, arm and leg. Professor Schäfer and I showed that the trunk was represented on the median surface of the hemisphere, and in a partial degree the face, arm, and leg also. Dr. Beevor and I believed that it would be possible to split up these large centres very minutely. We therefore divided the cortex into square areas, with sides of two millimetres, and then stimulated these small areas by weak currents. The results we have published in the Philosophical Transaction for 1887–1888 under the head of *Minute Analysis.* The general result has been to show that there is no hard and fast line limiting the representation of any given

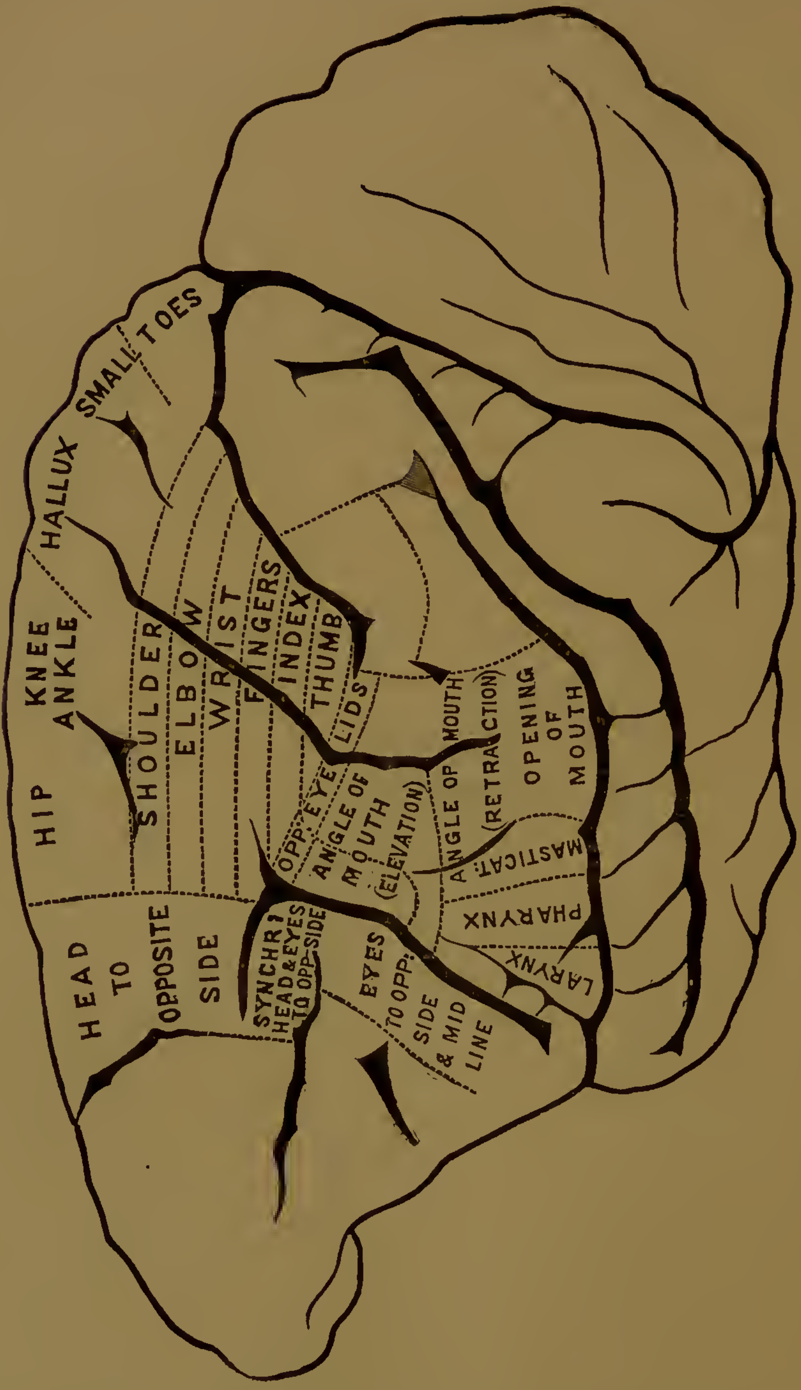

Fig. 12.

segment. I mean to say that there is no area of the cortex, over which any particular segment is equally represented throughout, but that in one spot especially the representation is concentrated and thence diminishes gradually; thus in the representation of the thumb, we find for example, that there is a focus, but that the thumb is represented over a great deal of the upper limb region, and that this representation diminishes in intensity gradually as we pass from the focus upwards. To give one more example: the shoulder and the thumb form the two great "purposive" parts of the upper limb, and we find that the shoulder is represented in exactly the opposite part of the upper limb region to that of the representation of the thumb. I can not do more now than thus indicate the mode in which we believe that the various segments of the body are represented. I have here a diagram, Fig. 12, showing the various foci of representation of all of the small segments of the body. Prof. Ferrier states that these areas are limited by hard and fast lines, that no one area trenches upon another. I can not follow my honored teacher in this belief. We are perfectly sure that there are what may be called border centres, and indeed in one portion of the brain, Prof. Ferrier has himself called attention to this fact. There are border centres and the area of representation of the face merges into that for the representation of the upper limb. If there was a focal lesion at that point, you would have the movements of these two parts starting together. You have then two "signal" symptoms, meaning that you have two movements of two different segments.

But I would go further. The general result of our observations has been to show that, just as in accordance with principles we should imagine to be the outcome of the evolution of the cerebral cortex, so we find that the larger muscles of the body are represented in the upper margin, then as we pass down, we have the representation of the smaller muscles, until as Dr. Semon and I showed, the representation for the adductors of the vocal cords is situated at the very bottom of all, just behind the foot of the pre-central sulcus.

I have said nothing with respect to the representation of the march of the spasm in the segments of the body, nor can I devote any time to that, for I should then have to give a catalogue of the foci above referred to. For this I must refer you to the original papers. For diagnostic purposes it is absolutely necessary for us to be aware of the relation of one focus to another. This of course was originally pointed out by Profs. Hughlings Jackson and Ferrier.

I shall now turn to the question of the representation of the character of movement. Prof. Ferrier in his monograph, published in 1874, pointed out that in certain parts of the so-called motor region, there are certain movements represented. Dr. Beevor and I have carried this further, and we have found that a gradation of the representation of different movements could be traced. I will give two examples. First, the mode of representation of extension and flexion. (Fig. 13.) At the upper part of the upper limb region, extension of

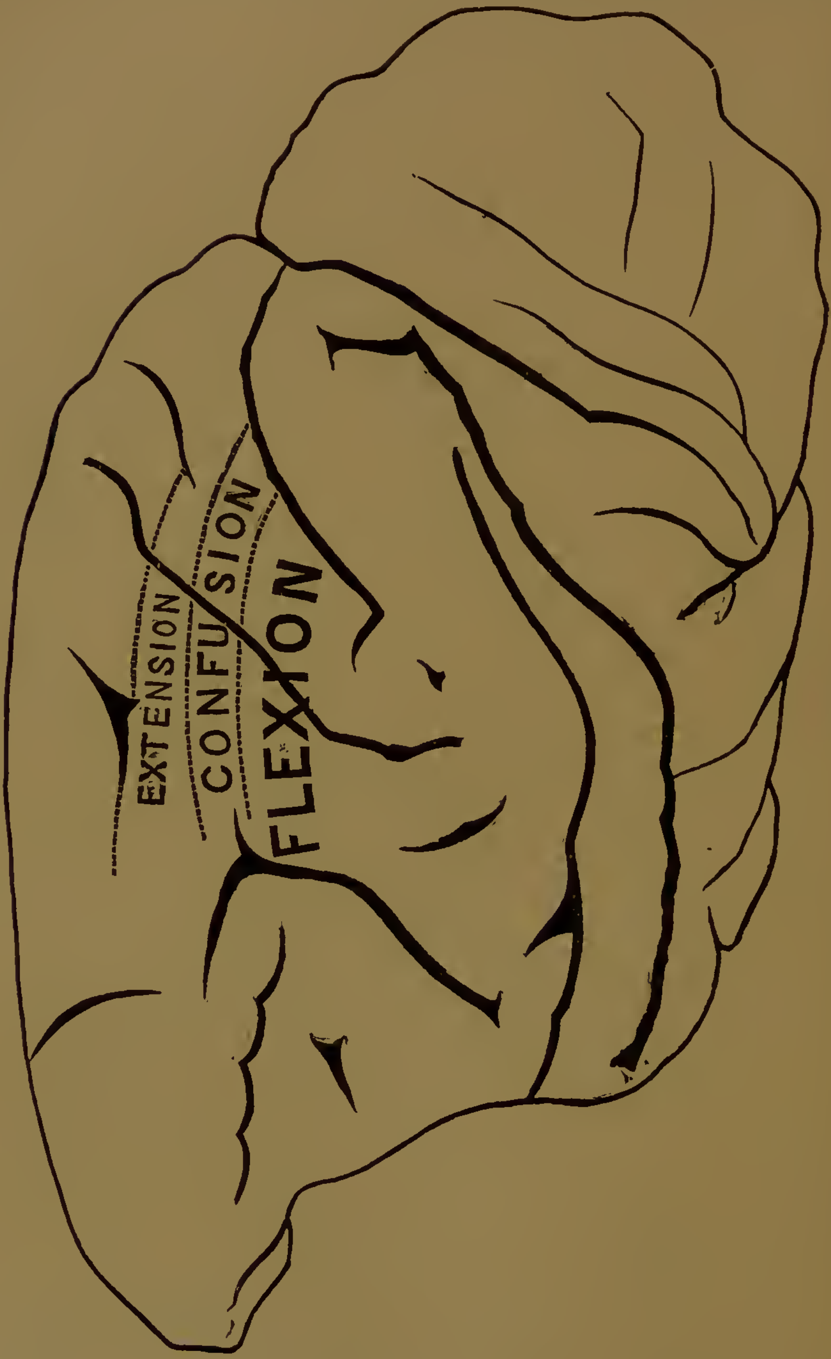

Fig. 13.

the elbow is represented, while in the lower part, flexion is represented and between the two we have confusion of the elbow, the limb moving in violent tremor, but as it were, not knowing which way to go. This law with variations holds true of the segments with which flexion and extension are associated.

I wish to give one more example of the importance of determining the character of the movement and it is one which gives me special pleasure. It is the example of the representation of extension of the wrist to which Dr. Keen referred* in the brilliant exposition of his cases before the Surgical Association yesterday. In his diagram, he has figured the exact spot where according to the observations of Dr. Beevor and myself, extension of the wrist is most represented, namely in the anterior border of the upper limb region. This point is of special interest to us because we believe that we are in a position to say that extension of the wrist must precede every fine movement of the hand. It would therefore be the most anteriorly represented kind of movement. This brings to a conclusion what I have to say in regard to the representation of movement.

Before entering on a new direction there is one observation which I want to make. It is that the facts observed by Dr. Beevor and myself are in close harmony with the facts more roughly observed by Prof. Schäfer and myself, but that there are minute points of difference. Now, these we have found to be due entirely to the species of monkey employed. For that reason, we now employ only one species, the *Macacus sinicus.* The evolution of the finer representations in the bonnet monkey is for practical surgical purposes exactly the same as in man. It is upon that alone that the diagnoses which I have shared with my colleagues have been founded. I am led to make this observation on account of the innumerable discussions which have taken place and are still continuing respecting the definite limits of various areas and to emphasize the necessity of employing one species for minute comparison, neglect of which must prolong debate without much profit.

I shall now turn to a totally different part of the subject. I wish to speak of cortical epilepsy by itself. Cortical epilepsy or Jacksonian epilepsy consists of several stages; the preliminary aura, the tonic stage, the latent period, the clonic stage, and finally the stage of exhaustion or paralysis. For several years I have been making observations to find out whether all of these kinds of spasms in the muscles are due to the cortex cerebri alone. Here we must look upon the convulsions from two points of view. We have to consider first the possibility of the cortex cerebri taking the initiative in the whole affair, or on the other hand we have to try to find out whether the one part of the convulsion may be due to the cortex, and the rest to the spinal cord, i. e., to the bulbo-spinal system. The junction of these systems, the cortical and bulbo-spinal, is brought about by the pyramidal tract. Obviously if we investigate the convulsed muscle by the ordinary graphic method, we should obtain a tracing as represented in the diagram, (fig. 14, I.)

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* Trans. of Am. Surg. Association, vol. vi., 1888, pp. 335–341.

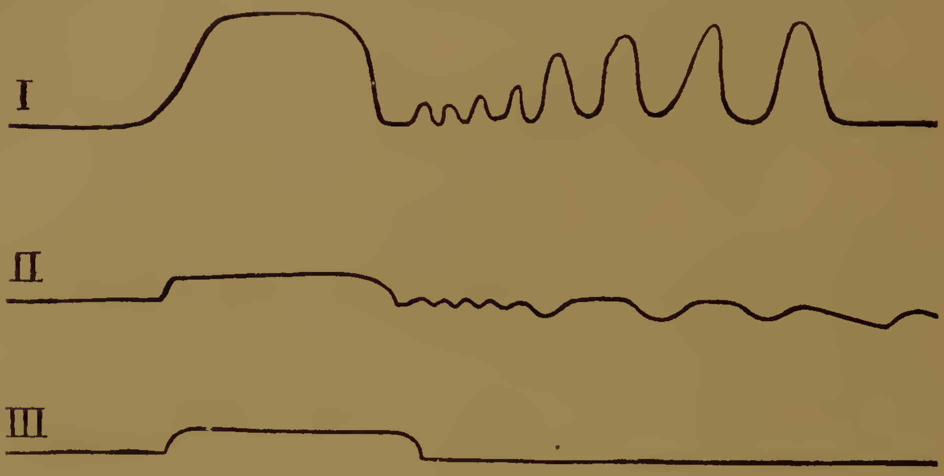

FIG. 14.

in which the uprising would indicate the tonic stage, then there would be a pause followed by a fall, and then little waves indicating the clonic convulsions which succeeded the tonic stage. It might be thought that the whole of this convulsion was due to the cortex, or it might be that the tonic stage was due to the cortex and the clonic to the spinal cord. It was found impossible with our former means of investigation to settle this point. The only way to decide the question was to tap as it were the pyramidal tract. I am glad to say that with the assistance of Dr. Gotch, I have succeeded during the past summer in accomplishing this. We found that it was possible to tap the pyramidal tracts in the dorsal region, then to stimulate the cortex and to measure with a delicate electrometer (fig. 15), the changes in the pyramidal tract. We have as a result of excitation negative variations occurring in the demarcation current, telling us what nerve impulses are coming down the pyramidal tract. It is perfectly justifiable for us to assume, as we do for ordinary electric phenomena in nerve, that these variations exactly correspond with the passing of nerve impulses. We know nothing of nerve energy itself except its rate of transmission, consequently we estimate its character by the constantly aroused electrical phenomena. We have thus found that the whole of the convulsion which we call Jacksonian, is due to the cortex. The drawing of the photographic record obtained from the electrometer is given in the diagram under the graphic record (fig. 14, II.) and you see that they absolutely correspond.

I shall now conclude with a few remarks on what is generally known as the practical part of the subject; for my own part, it seems to me that one division is as practical as another. I mean the scientific or

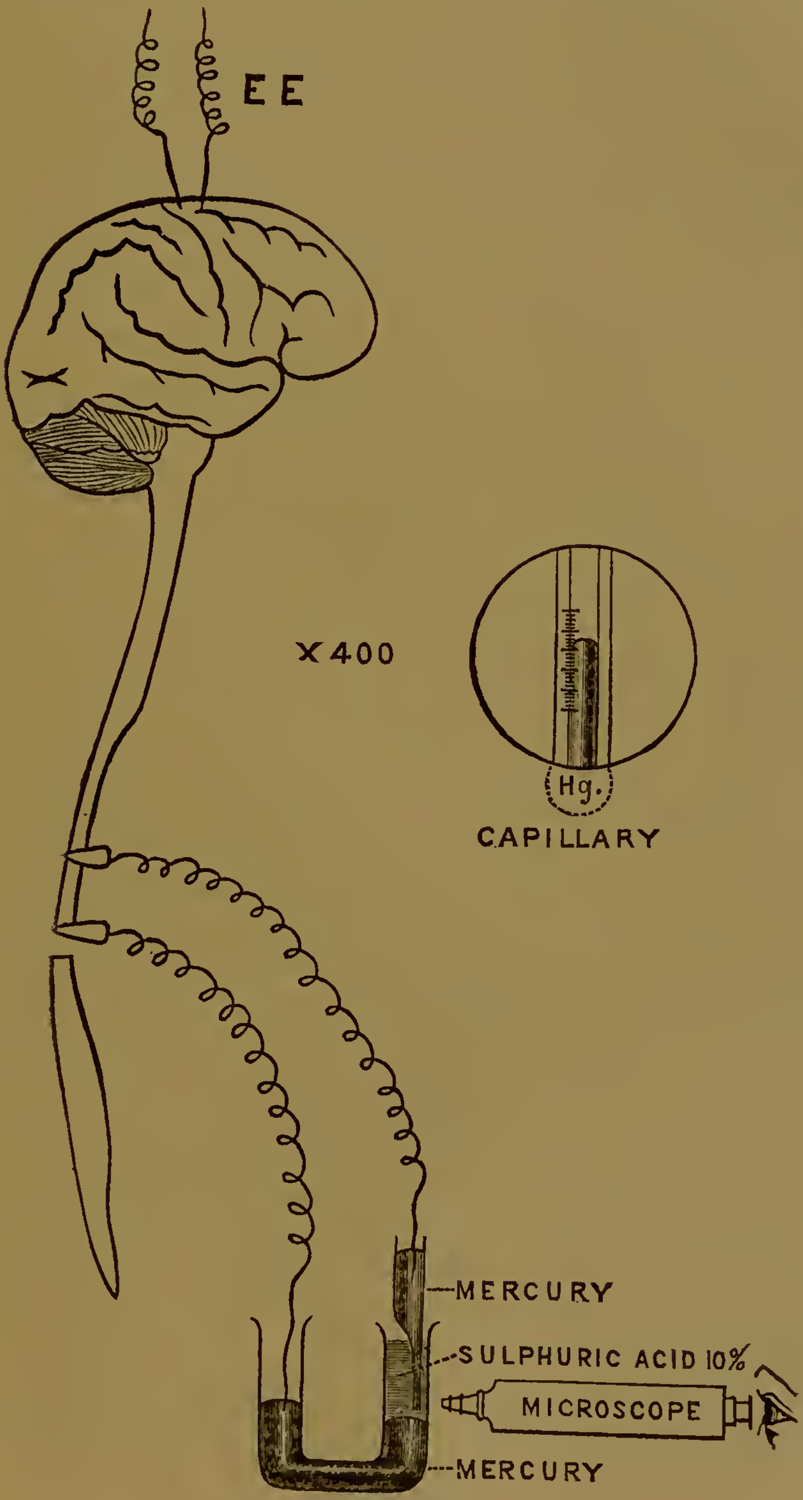

FIG. 15.

diagnostic as well as the surgical features of what is called cerebral surgery. I say what we call cerebral surgery, for after all there is no mystery about it. The ordinary rules of surgery are those which we should practice upon the brain. There are, however, necessarily, a few points of special character and to these I shall briefly allude.

I have nothing to add to what I have previously published on the subject of anesthesia except one word which I shall say presently. I have nothing to add as regards the marking of the bone with a fine drill through the scalp. I would suggest that the cutting out of the pieces of bone be done with a one inch trephine in order to determine the thickness of the skull, and that then with the circular saw invented by your countryman, Bonwill, a suitable area should be opened up by almost cutting through the skull, after which with powerful bone forceps, the area thus marked out can be quickly cut away. Before the forceps are applied, it is, of course, essential to separate the dura mater. The dura mater being exposed, if we are performing an exploratory operation, it is a terrible thing for the patient, if we do not open the dura mater. I am aware that we shall thus greatly increase the risk, if we have not been careful in our antiseptic precautions, but that is too obvious a point to require discussion. A striking example of the importance of always opening the dura has been brought to my notice. I trephined a case which had been previously operated on by Mr. Savory. He had not opened the dura mater. I opened the dura and found that there was a large cystic cicatrix fully two inches square. That experience has led me to always open the dura mater where I have found nothing abnormal in the bone.

With regard to faradism of the exposed brain, this is a point in which the activity of my American colleagues has gone further than we have in Europe. Very important practical points are to be gained by faradism of the cortex. I showed five years ago* that even faradism of the corpora quadrigemina (in a case of encephalocele) was productive of none but the best results. In the first place, I need hardly say that thereby we shall by direct observation upon man, done for his personal good, learn facts of value to his fellow men. I wish to point out the fact observed by Prof. Schäfer and myself, that if you are using antiseptic substances, to disinfect the wound you will find that washing with such substances will serve to render the cortex inexcitable. My friend, Dr. Lloyd, has referred to the fact that in his case the cortex seemed to be excitable only in patches. We saw this in the monkey under the above circumstances some years ago, and I thought then that it was a most important point for future reference in clinical work.

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*Brain, 1884.

Hemorrhage. I believe, as I have before stated, that parenchymatous oozing may be stopped by the previous use of morphia. We should certain try ergot as suggested by Dr. Keen, but first on the lower animals. The suggestion which I made with reference to cocaine I am very glad to see has been successfully followed. The ligature must always be applied if possible. Never pack the wound, packing is disastrous. I have seen it cause failure in almost every experimental instance. One method of applying the ligature is always successful :—that is with a curved needle to dip under the sulcus, bring up all the tissue in the sulcus, and then to tie very gently.

I wish now to refer to the one chief source of regret in this kind of surgery. I mean, of course, the death of the patient. I want to add to what has been said before but one point, and that is that it is exceedingly dangerous to operate upon a patient who is much under the influence of drugs, especially bromide of potassium. We should endeavor as far as possible to take our patient free from any influence of that sort. In regard to the other cause of death, referred to, namely shock, I count that as nothing. The patient is brought to the surgeon in a hopeless state ; the surgeon adds nothing to his condition, if his system proves unable to bear the operation.

Another regrettable point is of course failure to accomplish the object for which the operation was undertaken, more especially cure of the epilepsy. I shall refer to this only briefly. The recurrence, is, I believe, due almost invariably to incomplete operation. Those cases in which I have completely removed to my own satisfaction, not only the lesion, but also at least one centimeter of the surrounding brain tissue substance, have remained free from recurrence. The cases in which epilepsy has recurred have been those in which I did not remove to my own satisfaction the whole of the damaged brain substance around the lesion. This I consider to be in the majority of cases the cause of the recurrence.

We must all agree with Prof. Ferrier that the kind of fit from which the patient suffers is indicative of the probable success or failure of the operation. If a patient is brought to us, in whom although the fits began unilaterally, they are now usually bilateral, in origin, that case is to be looked upon with great suspicion. Operate by all means, for we should operate in all cases where drugs have failed, but the prognosis must be guarded. As also pointed out by Prof. Ferrier, the stage of the epilepsy is a most important feature. If we operate on such cases, it must be early, and this is a point which simply rests upon the personal courage of the diagnostician. Lastly, of course, we may have recurrence of a new growth.

Finally, it has been said that at this moment we are standing in some danger of doing too much in certain cases. I quite agree with what has been said on this point, but, on the other hand, I think that we stand in greater danger of doing too little, and this on account of statistics. The statistics which we have offered to us as showing the seat, the mode of growth and general character of tumors and of other lesions of the brain, are derived from investigations made at the time of the death of the patient. Such information I consider to be worth only a comparatively small figure. The real evidence upon which we can base an estimate of the value of surgical interference in brain lesions will be by the general accumulation of facts worked out in the laboratory and operating theatre.

Permit me to conclude by thanking you not only for the kind manner in which you have received me this evening, but also for the generous feeling of hospitality and friendship which has met me on my visit to this country.

Dr. W. W. Keen, of Philadelphia.

We distinguish in the body three different cavities, the cavity of the head, the cavity of the chest and the cavity of the abdomen and pelvis. In the chest, and the abdomen and pelvis we have separate and distinct viscera, with separate and definite functions, and we can investigate the diseases of each viscus and locate the disease according to its physical signs and the symptoms presented by the history of the cases. Until very recently the head has been regarded simply as a cavity containing one viscus, the brain, and that this acted in its entirety like the liver, spleen or kidney. If it were affected we were unable to distinguish one part from another. In my opinion we should now regard the brain cavity, as we do the chest, or the abdomen, as a cavity containing a number of viscera or organs fused physically but separable physiologically and pathologically. These viscera or organs are the centres or areas which have been pointed out of late and especially by the investigations of our distinguished guest of this evening. If we recognize that the head cavity contains a number of viscera and that each viscus has its own functions, diseases, injuries, symptoms and physical signs, we shall at once clear up our conception of the functions of the head, and we shall bring it into line with the other cavities containing viscera which may naturally be subjected to investigation and operative interference.

I am glad that a warning note has been sounded to-night both by Dr. Ferrier and Mr. Horsley as to over-rashness. We are only on the threshold and are just beginning to find out what operative surgery can do in the brain. We are in great danger of over-doing in "Brain Surgery," as has been the case in operations for the removal of the ovaries and tubes and for laceration of the cervix. On the other hand, while we must be cautious not to do too much, we must be equally cautious in the other direction. We must take a lesson and a warning equally potent, from the history of operations within the abdominal cavity. The timidity with which surgeons in former days approached the abdominal cavity was remarkable. The boldness with which now we attack every lesion of that cavity is almost appalling and the success equally gratifying. We shall have the same history, the same cautiousness, the same boldness and the same success in the head cavity.

I was glad to hear Dr. Park advocate exploratory operations. We must do with the head cavity what we do with the abdomen. As Mr. Durham remarked last night, we must sometimes open the abdominal cavity *in order* to make a diagnosis: so we must do in the head. We must learn from experience the lesson how far we can go and where we must be stayed, and at present we have to *make* the experience. A good illustration of this was furnished recently. A gentleman consulted me with reference to an intense, persistent headache in the back of the head with paralysis and other serious troubles, probably the result of a fall, possibly the result of a syphilitic lesion. I called to my aid Dr. Mills and Dr. Oliver, the latter of whom examined the eyes carefully but we could not find any localizing symptoms and it seemed impossible to determine where to apply the trephine if at all. I therefore declined to operate on the ground that we could not see precisely the reason to go in above or below the tentorium. This same patient went to my friend Dr. Weir who did trephine, basing the operation, as I understand it, upon the point of greatest intensity of the headache and he has cured the patient. He simply trephined without opening the dura. What was the exact nature of the trouble? I do not know and I suppose that Dr. Weir does not know, but he did better by the patient. This simply illustrates what boldness may sometimes do, and will guide us in similar cases in the future and eventually will teach us the proper limitations of operative interference.

Dr. Robert F. Weir, of New York.

I have always been handsomely treated by the physicians, and to-night I have been equally well treated by my surgical friend and rival, Dr. Keen, in his allusion to the case of cerebral pain in which I last operated.

It has been my good fortune, beginning in 1883, to practice what is now called brain surgery in ten instances, three times for tumors, three times for cerebral abscess, twice for hemorrhage into the cerebrum where there was no external injury to indicate its locality, once for epilepsy, and once for what I have called cerebral pain. The last case of tumor which has recently been made the subject of a paper by Dr. Seguin and myself, is exemplified in the brain that I shall pass around. On the right side is indicated the situation of the tumor and the cross-section on the other side gives another view of the same. This case illustrates a point of some importance to us concerning the value of interference in infiltrating neoplasms in this region. The tumor was so deep that on exposing the brain we were within an ace of not finding it, although the symptoms fully indicated its presence. It was only detected by very firm palpation and with difficulty, from its depth, for I had to go in an inch and a half before I could remove it. It was found to be an infiltrating sarcoma about the size of the end of my finger. A serious prognosis was given. The operation was done in November, 1887. The patient at once improved in condition and is still living, but there are present signs of renewed development of the tumor.

There is one point about these cases of tumor to which I should like to refer. In that I must ask you to accept with reserve the opinion of an eminent surgeon, so eminent that I should put this forth with some hesitation were it not that it is based not only upon information derived from my own experience but from that of others. Bergmann has said that an operation for the removal of a brain tumor should not be undertaken, first when the patient is in a state of coma, and second, when the tumor is a large one. Dr. Keen has, however, removed a tumor weighing over four ounces and the patient has recovered, and Mr. Horsley has removed with a successful result a tumor weighing over four and a half ounces. In Mr. Horsley's case not only was the tumor large, but the patient was in a state of coma. The facts thus contradict the theory.

I want to say further a word about a mishap which occurred in the first case of tumor on which I operated. There was an error in diagnosis. The cranium was opened, the brain exposed and explored, but no tumor was found. No bone was replaced, but the skin was fastened over the gap and the patient recovered. To my pleasure the headache under which the patient was laboring disappeared and the paralysis improved. She lived two months subsequent to the operation and only at the last did additional symptoms of paralysis develope. I had relieved the counter pressure. Another case was reported subsequently by Mr.

Heath in which he exposed a tumor, but it was so large and so attached to the base of the skull that it was not removed, but in the same way relief was given, the headache disappeared, the paralysis improved and the epilepsy ceased for a time. This is an important point and bears upon another class of troubles referred to by Dr. Mills. I have reference to apoplectic hemorrhage.

Dr. Mills has shown at what point we are likely to reach the seat of such hemorrhage. My feeling is that in the severer form of these cases we should resort to an exploratory cranial operation, take away a goodly portion of the skull, and if happily we find the blood clot, remove it. If we do not find it, we shall relieve the patient of the counter-pressure of the bony envelopes and in this way perhaps give sufficient additional time during which the powers of nature may do something for the patient.

At Dr. Seguin's suggestion, I have during the past two years gone over the brain to see what could be done surgically, irrespective of localization, and to find out among other points whether the longitudinal and lateral sinuses were parts that we necessarily should avoid. We can, however, strip these up from the bone for a considerable distance. I have done this in the living subject, for instance to the lateral sinus for an inch, and have in times gone by even wounded it without unpleasant results—checking the hemorrhage by plugging. Now-a-days we are prepared if necessary to clamp and tie these large venous trunks. In cases of ear disease I have raised up the dura mater in exploring for a distance of an inch and a half on the anterior and on the posterior surface of the temporal bone. I have likewise been able to lift up the frontal lobes until the anterior clinoid processes were exposed. I have been able to feel, in one instance, the foramen magnum. I have also recently tapped a cerebral abscess on the under surface of the sphenoid bone, just anterior to the foramen rotundum and ovale, being led to this region by bone necrosis. I believe that we can reach a great many portions of the brain, hitherto untouched, if our neurological friends give us the indications; for few of us possess in the same happy degree as Mr. Horsley does, the qualifications of the neurologist and the surgeon in one body. I have learned a good deal from him to-night. We are all thankful to him for starting us in this way. May he long continue to work well in it, and may we follow rapidly after him.

EXPLANATION OF THE TABLE OF CASES, AND DIAGRAM, ON APHASIA.

In the table of cases are included those cases only in which Broca's centre was found to be unaffected by disease. The situation of the lesion in any case is to be found by referring to the diagram and looking for the number of the case.

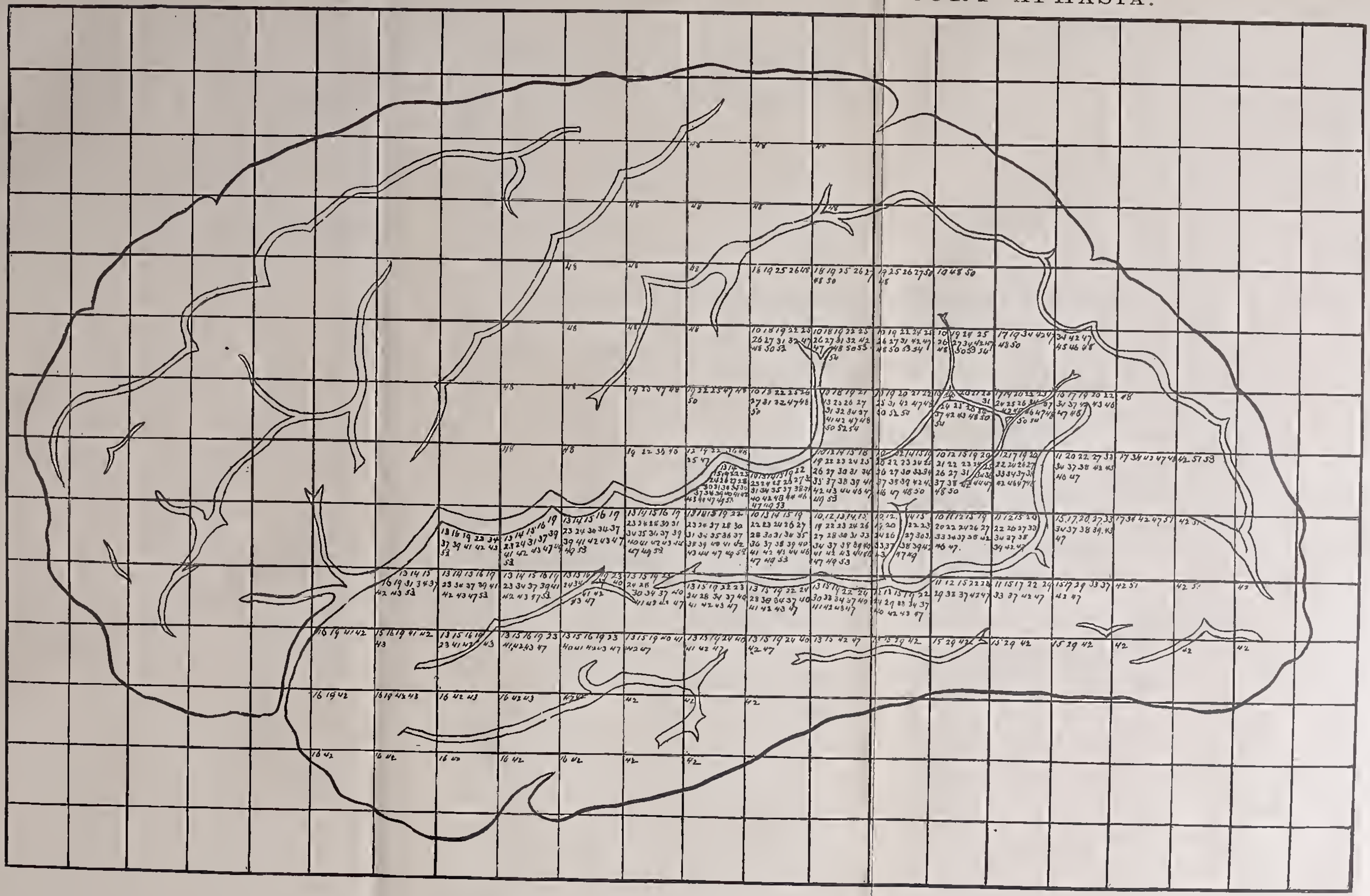
When in the account of the symptoms no record of certain powers was made, a blank is left in the appropriate space.

The cases are arranged in the order of their publication.

TABLE OF CASES OF SENSORY APHASIA.

No.	Author.	Reference.	Power to recall words.	Power to understand speech.	Power to read.	Power to speak voluntarily.	Power to repeat words heard.	Power to write voluntarily.	Power to write at dictation.	Power to copy.	Power to read aloud.
10	Bateman.	On Aphasia, 1870, p. 73.	Impaired.	Lost.	--------	Good.	-------	Lost.	---------------	-------	----------
11	Broadbent.	Med.-Chir. Trans., 1872, p. 162.	Impaired.	Good.	Lost.	Good.	-------	Good.	Good.	-------	Lost.
12	Gogol.	Dissert., Breslau, 1873.	Impaired.	Impaired.	Good.	Impaired.	Good.	Impaired.	Good.	-------	Good.
13	Wernicke.	Aphas. Sympt. Comp., 1874 (10).	Impaired.	Impaired slightly.	Good.	Fair (some paraphasia).	-------	---------------	---------------	-------	Substituted strange words.
14	Wernicke.	l. c. (2).	-------	Lost.	--------	Good.	-------	---------------	---------------	-------	----------
15	Troissier.	Gaz. Medical de Paris, 1874, p. 25.	-------	Lost.	--------	Impaired (jargon).	-------	---------------	---------------	-------	----------
16	Kussmaul.	Ziemssen's Cyclo., xiv., p. 765.	Lost.	Lost.	Impaired.	Good.	-------	Letters, not words.	---------------	-------	Good, but did not understand.
17	Kussmaul.	l. c., p. 763.	Impaired.	Good.	Impaired.	Impaired.	-------	Impaired.	---------------	-------	----------
18	Goetz.	Bull. de la Soc. Anat. Paris, 1876, p. 81.	Impaired.	Lost.	--------	Impaired.	Lost.	---------------	---------------	-------	----------
19	Sabourin.	Progrès Méd., 1877, p. 70.	Impaired.	Impaired.	Lost.	Very limited.	Lost.	Impaired.	---------------	-------	----------
20	Bulteau.	Bull. de la Soc. Anat., 1877, p. 282.	-------	Impaired.	--------	Impaired.	Good.	---------------	---------------	-------	----------
21	Sigaud.	Progrès Méd., 1887, p. 177.	Good.	Good.	Good.	Good.	Good.	Lost. could not call to mind appearance of words.	Impaired.	Impaired.	----------
22	Broadhent.	Lancet, 1878, I., p. 312.	-------	Lost.	Lost.	Impaired (jargon).	-------	Lost.	---------------	-------	----------
23	Riedel.	Dissert., Breslau, 1877.	-------	Lost.	Impaired.	Impaired (jargon).	-------	Impaired.	---------------	-------	----------
24	Fritsch.	Wien. Med. Presse, 1880, p. 463.	-------	Lost.	--------	Impaired (jargon).	-------	---------------	---------------	-------	----------
25	Ball and Seguin.	Arch. of Mêd., 1881, p. 136.	Impaired.	Impaired.	Impaired.	Good (slight mistakes).	-------	Impaired.	Lost.	Impaired.	----------
26	Chauffard.	Rev. de Mêd., 1881, p. 939.	-------	Lost.	--------	Impaired (jargon).	-------	---------------	---------------	-------	----------
27	Weiss.	Wien. Med. Woch., 1882, 334.	-------	Lost.	Lost.	Lost.	Lost.	Lost.	---------------	-------	----------
28	Giraudeau.	Rev. de Mêd., 1882, ii., p. 446.	Good.	Lost.	Good.	Good.	-------	Good.	---------------	-------	----------
29	Claus.	Irrenfreund, 1883, p. 82.	Impaired.	Impaired.	--------	Good.	Good.	Lost.	Lost.	Lost.	----------
30	Claus.	l. c., p. 88.	-------	Lost.	--------	Good.	-------	---------------	---------------	-------	----------
31	D'Heilly.	Gaz. Méd. de Paris, 1883, p. 22.	-------	Lost.	Lost.	Impaired at first.	Lost.	Lost.	Lost.	Lost.	----------
32	Webher.	Bost. Med. and Surg. Jour., 1883, p. 580.	-------	-------------	--------	Impaired (misplaced words).	-------	Lost.	Lost.	-------	----------
33	Schütz.	Charité Annalen, xiii., 481.	Impaired.	Lost.	--------	Good.	-------	Impaired (jargon).	Lost.	Lost.	----------
34	Balzer.	Gaz. Méd. de Paris, 1884, p. 97.	Impaired.	Impaired.	Lost.	Impaired.	Good.	Lost.	Lost.	Lost.	----------
35	Rosenthal.	Centralhl. f. Nervenheilk., 1884, p. 1.	Impaired.	Lost.	Lost.	Impaired (few words).	-------	His name only.	---------------	-------	----------
36	Lohmeyer.	Arch. f. Klin. Chir., xiii., 323.	Impaired.	-------------	--------	Impaired.	-------	Lost.	---------------	-------	----------
37	Amidon.	N. Y. Med. Jour., 1885, p. 113.	Impaired.	Lost.	Lost.	Fair (misnamed ohjects).	-------	Lost.	Lost.	-------	Jargon.
38	Gunther.	Zeit. f. Klin. Med., 1885, p. 16 (37).	-------	Lost.	--------	Impaired (jargon).	-------	---------------	---------------	-------	----------
39	Monakow.	Arch. f. Psych., xvi., p. 166.	-------	Lost.	Lost.	Good.	-------	---------------	---------------	-------	----------
40	Seppilli.	Functionslocal., p. 208.	-------	Lost.	--------	Articulation good, sentences confused.	-------	---------------	---------------	-------	----------
41	Seppilli.	l. c., p. 205.	Impaired.	Lost.	--------	Impaired (jargou).	Good.	---------------	---------------	-------	----------
42	Seppilli.	l. c., p. 182.	-------	Lost.	--------	Lost (jargon).	-------	---------------	---------------	-------	----------
43	Petrazzani.	Revis. Sper. di Fren., xii, 235.	-------	Lost.	--------	Good.	-------	---------------	---------------	-------	----------
44	Eichhorst.	Corresp. Schw. Arzt., 1886, 696.	-------	Lost.	Lost.	Good.	-------	---------------	---------------	-------	----------
45	Henschen.	Neurol. Centralhl., 1886, 424 (2).	-------	Impaired.	Lost.	--- ------------------------------	-------	---------------	---------------	-------	----------
46	Henschen.	l. c., case (3).	-------	Good.	Lost.	Lost.	-------	Lost.	---------------	-------	----------
47	Perret.	Clinique Mêdical, p. 137.	-------	Lost.	--------	Impaired.	-------	---------------	---------------	-------	----------
48	Hun.	Amer. Jour Med. Sci., 1887, 154.	-------	Good.	Lost.	Impaired slightly.	-------	Lost.	Impaired.	-------	Lost.
49	Hitzig.	Verh. d. Cong. f. Inn. Med., 1887, p. 166.	-------	Lost.	--------	Good.	-------	---------------	---------------	-------	----------
50	Dejerine.	Progrès Méd., 1880, p. 629.	Impaired.	-------------	Lost, did not understand.	Impaired.	-------	---------------	Good, but did not understand what he wrote.	-------	Good, but did not understand.
51	Bernheim.	Hecht, Thêse de Nancy, 1887.	Impaired.	Good.	Lost.	Good.	Lost.	Lost.	Lost.	-------	Lost.
52	Wilhrand.	Seelenhlindheit, p. 180.	Impaired.	Good.	Impaired.	Good.	-------	Never learned.	---------------	-------	----------
53	Laquer.	Neurol. Central., 1888, p. 340.	-------	Lost.	Lost.	Impaired (jargon).	Lost.	Never learned.	---------------	-------	----------
54	Macewen.	Brit. Med. Jour., 1888, Aug. 11.	Good.	Good.	Lost.	Good.	-------	---------------	---------------	Lost.	----------

DIAGRAM OF LESIONS IN CASES OF SENSORY APHASIA.



THE PRESIDENT'S ADDRESS.

BY JOHN S. BILLINGS, M.D.,
SURGEON, U. S. A.

ON MEDICAL MUSEUMS,

WITH SPECIAL REFERENCE TO THE ARMY MEDICAL MUSEUM AT WASHINGTON.

GENTLEMEN OF THE CONGRESS:—Our articles of confederation require that the President shall give an address. In endeavoring to comply with this regulation I must ask your indulgence, for, while I think I have something to say, I cannot give you such a discourse as would befit the audience, the occasion and the subject.

The prominent characteristic of the great majority of the societies composing this Congress is that their members have, as a rule, been chosen because they have either made some valuable contribution to medical literature, or have in some way, rendered aid to the profession; in other words they are supposed to be men whose labor and thought have not been confined to their own interests, or to those of their own patients. It may, therefore, be assumed that you are all interested in medical science, not merely as a means of giving new modes of diagnosis or of treatment, but also for its own sake, for the sake of knowing, for the pleasure of investigation, and in the hope of helping others, and that, while the majority have devoted themselves more or less to special branches, they have not, in so doing, lost interest in what may be for the general good of the whole profession.

I am here as the representative of the medical department of the general government, which has need of the best knowledge of all the specialities, and is beginning, in its turn, to do something for each.

The physicians in the government service are all general practitioners, and are expected to have such an education and training as will fit them to deal, alone and without consultation, with the diseases and injuries to which men, women, and children are liable. You have been, and still are, their teachers—in the lecture room and the hospital before they entered the service—in your text books, monographs, and contributions to journals or transactions which follow them to their widely scattered posts of duty. They are your warm friends; the more you discover, the greater your skill, the more recognition which your work receives, the better they are pleased.

Within the last twenty-five years the general government has, in its turn, done something for medicine and for you, by founding and maintaining a medical library and museum in Washington under the direction of the Medical Department of the Army.

I have had occasion several times to call attention to the library, which no doubt is that part most immediately useful to physicians, and which has attracted most attention. To-night I propose to speak of the other branch, in whose proper development it is desirable that you should take an intelligent interest, and after giving a brief sketch of the development of modern medical museums we will consider more especially our own national medical collection as it is, and as it ought to be.*

The origin of collections of objects of natural history was possibly, as suggested by Beckman, the custom of keeping curious objects in temples; but we have no record of the formation of any collections, specially connected with anatomy or medicine before the sixteenth century. It is true that human anatomy had been introduced in the schools by Mundinus in 1306, and that no doubt in Bologna, in Paris, and a few other places, a skeleton or two was preserved for purposes of instruction; but alcohol was unknown as a preservative before the end of the fifteenth century, anatomical details were of no interest until Vesalius had stirred up controversy with the Galenists, and injected preparations were not thought of until after Harvey's announcement, in 1628, of the discovery of the circulation of the blood.†

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* As a "museum," in the original sense of the word, is a building or place in which are collected objects of interest to the muses—that is, objects of art literature, etc.—the phrases "medical museum," "museum of pathology,"—etc., would have seemed quite improper in the days of Hippocrates, just as the prevailing pronunciation of the word mu′seum grates on the ears of the elders accustomed to the strictly proper way—*i. e.* muse′um. Custom has, however, so strongly sanctioned the use of the word museum in the sense of a collection of different articles, that it would be folly to attempt to give it a more limited signification, and, though lexicographers still recognize only the word as accented on the penultimate syllable, the tendency to accent the first syllable is so strong and constant that it is safe to predict that mu′seum will, in popular usage in this country, ultimately win the day.

† For accounts of the collections formed between the days of King Solomon and the end of the seventeenth century, consult tome ii. of the Musei Museorum of Michael Bernhard Valentin, in folio, published at Frankfort in 1714, wherein are curious engravings of many of the wonders contained in these museums. See, also, Hagen (H. A.), The history of the origin and development of museums, American Naturalist, 1876, x., p. 80.

The introduction of the use of the microscope at the beginning of the seventeenth century, and the collections of preparations for use with this instrument made by Leeuwenhoek and Ruysch, gave a powerful stimulus to formation of museums of this kind. The most famous of these collections was that of Ruysch, purchased in 1717 by Peter the Great, and sent to St. Petersburg. Ruysch was practically the first to prepare injected anatomical specimens for permanent preservation, and, if the stories told of his work are true, he made preparations which have never been surpassed. His museum was a very ornamental one, the bones and skeletons being arranged in various devices, the plants in bouquets, while scattered through the whole were beautifully engrossed sentences from the Latin poets.

The most famous medical museum in the latter half of the eighteenth century was that founded by Fontana, at Florence. This still exists, filling a series of rooms, and consists mainly of wax preparations, beautiful to look at, but inaccurate, and of little scientific value.*

During the first half of the present century a number of private collections were formed by anatomists, pathologists and surgeons. Most of these have become public collections, either by gift or purchase, and the rest have been dispersed or destroyed. There is not in existence, at the present time, any large collection of specimens pertaining to human pathology which is the property of an individual, and is at all comparable to those made by John or William Hunter, Astley Cooper, Howship, Liston or others. Commenting on this fact, Sir James Paget writes me that he does not know of any large private pathological collection, and that he believes the change to be entirely for the better.

The necessities of modern progress in anatomy, physiology and pathology, have led to the creation of medical museums in all parts of the civilized world. In most of the continental capitals these are connected with universities supported by the state. In Great Britain and in this country they are, as a rule, connected with private, or semi-private institutions for medical teaching. This difference is caused by the relative position which medicine holds in the educational machinery of the state in different countries. Where medical education is furnished by institutions directly supported by the government, the museums, which are a part of the apparatus required, are of course also supported by the government.

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* The first use of wax models to represent pathological specimens of dissected preparations of parts of the human body is attributed to a Sicilian priest, Gaetan Jules Zambo, who lived in the latter part of the seventeenth century, and who had been accustomed to make wax models of diseased or deformed hands, feet, etc., to be used as *ex voto* offerings at the shrines of certain saints. The fame of these induced a Florentine surgeon, Ricci, to visit the priest and to get him to model some pathological specimens which he furnished. A Franciscan, named Desrones, brought this art to France, and made many such models between the years 1703–1706, and Bianchi formed a large collection of the same kind in Italy. It was scattered after his death, and the last vestiges of it were two models representing a healthy and a diseased liver, which were to be seen in Innspruck in 1766. (Percy et Laurent, in Dict. des Sci. Méd., Paris, 1818, vol xxxv., article "Museum.")

Through the aid of friends, whose kindness in replying, or in obtaining replies, to somewhat troublesome inquiries, I cannot sufficiently acknowledge, I have obtained certain data with regard to some of the most important medical museums now existing in the world, and a part of these data are summarized in the table before you.* Evidently the city having the most valuable aggregate of anatomical and pathological specimens at the present time, is London, which contains the collections of the Royal College of Surgeons, of St. Thomas's, Guy's, St. Bartholomew's, St. George's and other hospitals, and of University College, the College of Physicians, and others. The oldest public anatomical museum in London is probably that of St. Bartholomew's, which, in 1726, had a room set apart for the purpose under the charge of John Freke, and which received the private collection of Abernethy. The most important medical museum in the world, and the one which has exercised the greatest influence in giving direction to anatomical and pathological studies, and in serving as a model for the formation of other collections, is undoubtedly that of the Royal College of Surgeons of London, the foundation of which was the collection made by John Hunter, purchased by the government in 1799. In one sense it is not a government institution, the funds from which it is now supported not coming directly from government grants; but, in another sense, it is truly such, since the College may be looked upon as an agent of the government having special charge of matters connected with medical education, as it is the principal examining body for those proposing to practise surgery in Great Britain.

The great value of the Hunterian collection lies in the breadth of its scope, which includes every branch of medical science; but it is preëminent in illustrations of human morphology and its abnormities. The museums of the great hospital medical schools are relatively richer in the department of pathological anatomy, specimens of which they have greater facilities for obtaining. Among these there is, of course, a certain amount of duplication of matters of interest; but no two pathological specimens are precisely alike, and the question discussed in the Paris school one hundred and fifty years ago, viz: "*An pro distinctis ægris ægritudines diversæ?*" is one that often occurs to a curator as he examines new specimens which differ but little from those already in his collection, but which do differ in some respects, and with regard to which he must decide as to whether, upon the whole, they are worth the trouble and cost of preservation.

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* See Appendix.

Edinburgh and Dublin have also each large and valuable collections pertaining to anatomy and medicine.* In Paris the medical museums are those of the Faculty of Medicine, including the Musée Dupuytren devoted to pathological anatomy, and the Musée Orfila devoted to human and comparative anatomy, materia medica, natural history and instruments and apparatus.

Professor Leon Le Fort, to whom I am indebted for data with regard to these collections, remarks that a large proportion of the anatomical specimens of the Orfila museum come from candidates who take part in concours opened for position connected with the anatomical teaching of the faculty—such as prosectors, demonstrators, etc., each candidate being required to furnish from ten to thirty specimens.

The medical museums of other European countries are connected as a rule with universities, and it is to be remembered that in these the different branches of medical instruction are each both more specialized and more comprehensive than is the rule with us. The professor of anatomy, of physiology, of pathology, has each his own building or institute, and, therefore, each his own museum; and unless this fact be held in view, comparisons between Continental and English, or American, medical collections may give very erroneous results.

With regard to the museums connected with American Medical Schools I will say little, referring you to the table and appended notes for such data as I have been able to collect. I am aware that in so doing I put aside a splendid opportunity to enlarge upon the general superiority of all these collections and the peculiar excellencies of each, but I think that you all know as much about these as I do and there is time only for details with regard to the one American Museum in which I am specially interested. I will say only that the best museum connected with a medical school in this country is the Warren Museum in Boston, and that the history of the collections of wax models, upon which several of our museums have expended large sums of money, is very instructive as to how not to do it.

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*I am indebted to Sir James Paget for the information given with regard to the greater number of the British museums. I had originally intended to attempt to obtain such data only from four or five of the largest; but on sending my little list of questions to Sir James he took such a kindly interest in the matter as to send a copy of these queries to a number of other museums with the request that they might be answered.

So far as mere number of specimens is concerned our own national medical collection is one of the eight largest in the world, and is increasing more rapidly than any other.

This collection, known as the Army Medical Museum, owes its inception to Dr. Wm. A. Hammond, one of whose first acts after becoming Surgeon-General, in 1862, was to issue a circular stating that "as it is proposed to establish in Washington an Army Medical Museum, medical officers are directed diligently to collect and to forward to the office of the Surgeon-General, all specimens of morbid anatomy, surgical or medical, which may be regarded as valuable; together with projectiles and foreign bodies removed, and such other matters as may prove of interest in the study of military medicine or surgery."* By the end of the year over a thousand specimens had been collected, and the catalogue printed in 1866 showed that it contained 7716 specimens. To the administrative ability and personal influence of Surgeon-General Joseph K. Barnes, we are indebted for the successful establishment of this Museum on a permanent basis, and to the labors of Doctors John H. Brinton, J. J. Woodward and George A. Otis, of the Army, are due its scientific value and importance. It is not my purpose in this address to trace the history of its development; that must be done elsewhere. It has recently been placed, with the Library, in a conveniently arranged fire-proof building, and on the first of July last contained over 15,000 specimens besides those contained in its microscopical department, divided as follows:

Comparative Anatomy	1,689
Pathological	8,354
Medals	384
Microscopical specimens	10,416
Normal Human Anatomy	2,961
Instruments and Apparatus	814
Microscopes	141
Miscellaneous	835

Besides these there are 375 specimens pertaining to normal human anatomy and 726 to pathological anatomy, which are in what is called the provisional series.

It is not, however, by number of specimens that the importance and value of museums of this kind can be judged; and in this case such a comparison would give an exaggerated and erroneous idea of the value of this collection. My object in this address is not to boast of what we have, but to indicate what we want; to point out what a National Medical Museum, arranged to meet the wants and interests of this country, should be, should have, and should do, and to suggest some of the ways in which this is to be brought about.

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* Circular No. 2, Surgeon-General's Office, Washington, D.C., May 21, 1862.

At first the Army Medical Museum was limited to military medical subjects, but of late years its scope has been greatly broadened, and is now nearly the same as that of the Royal College of Surgeons. It includes human anatomy, physiology, pathology, somatological anthropology, instruments and apparatus, and illustrations of methods of teaching connected with special departments of practical medicine. It does not at present include hygiene or materia medica, except in their immediate relations to the military medical service, and this for reasons which will be stated presently. That our National Medical Museum should be broad and comprehensive in its scope there can be no doubt, its requirements in this respect being quite different from those of collections formed and used more especially for the purpose of teaching medical students. The most practically valuable of these last are those formed by individual professors to suit their own specialties and methods of teaching. They need not, as a rule, be large. I may even say that they should not be large; for the labor of properly preserving a large collection is great, and the student, with his limited time and want of knowledge of what to look for, can examine but few specimens so as to profit by them. For the same reason specimens of rare abnormities, of double monstrosities, etc., are of little use in ordinary medical teaching as given in this country, and are not specially desirable in the museums of our medical schools.

You may have noticed that, in speaking of the scope of our museum, I said it included "human anatomy." This phrase does not mean that it has no specimens illustrating the structure of other animals,—for it has many, and needs many more; but it means that in this department its main purpose is not to make comparative anatomy an end to itself by exhibiting all known variations in structure throughout the animal kingdom as a basis for their study in relation to development and environment, causation and results. In other words, it is not an anatomical museum but a medical museum. The broad field of general biology, including natural history and comparative anatomy, will ultimately be covered by the National Museum, and in our medical collection it will be quite enough to illustrate human anatomy fully, using so much of the structure of the lower animals as will be useful in explaining why certain parts of the human body are thus, and so, and not otherwise. No sharp line of distinction can be drawn between the field of work of the general, and that of the medical museum. So far as morphology is concerned, they must necessarily overlap somewhat, since both want a certain number of the same specimens, although using them to illustrate different points of view.

The medical museum should possess a series of specimens showing the normal anatomy of the domestic animals, or of animals used in experimental pathology, pharmacology or physiology as a basis for comparison with abnormal or pathological specimens derived from the same animals. It is in the section of embryology, illustrating laws of heredity and development, that specimens from the lower animals are most interesting, and this is especially the case in the study of human abnormities and monstrosities. It is quite possible that to some anatomists it may seem that no limitation should be placed to the scope of the museum in this direction, for it is easy to trace some connection between any variation in structure in any animal and some structure, normal or abnormal, in man, but the limitation is placed, with reference to the work of the National Museum, so as to secure the best results.*

The kind of specimens most valued for illustrating anatomy in a museum is now very different from what was sought for in the first half of this century. Dried and varnished dissections showing blood-vessels, etc., are now looked on as nearly useless, and are kept only as historical relics. Elaborate dissections under alcohol, mounted in opaque dishes, with flat glass covers, and sections of frozen bodies, similarly mounted, are what the student and the practitioner most desire to see. In our museum there are some excellent specimens of this kind, prepared under the direction of Professor His, of Leipzig; or Professor Cunningham, of Dublin; and by our own anatomist, Dr. Wortman. These, however, are only samples to show how the work should be done. We require several hundred such specimens to illustrate properly regional anatomy in relation to age and sex, while the possible applications of the same methods to the illustration of visceral displacements, hernias and deformities of all kinds are boundless. As regards physiology, but little can be done by museum specimens to illustrate function as distinguished from form and structure. The so-called physiological series in the Hunterian collection, is a series of organs illustrating variations in different families of the animal kingdom or at different ages; in other words, it illustrates ontogenic and phylogenic development. The things students or teachers of physiology are most anxious to see in a museum are specimens of instruments and apparatus employed in experimental physiology, or in the measurement of the special work of different organs, or in illustrating lectures on physiology. Illustrations of results obtained in experimental pathology often belong quite as much to physiology; as, for example, specimens of results of Gudden's atrophy method.

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*In the great majority of medical schools in this country anatomical teaching has a much more limited field than in the German universities, and our professors of anatomy, following English traditions, are usually in training for surgery. We have, however, several who are devoting their entire work to anatomy in the broad sense, and for its own sake, and it is in this direction that progress will be made.

The Army Medical Museum has only a beginning of such an anatomical collection as I have indicated as desirable. Like all other museums, it is richer in specimens illustrating osteology than in any other branch of anatomy, simply because such specimens are the easiest to obtain and preserve. We are accustomed to think that human anatomy is nearly exhausted as a field for original research, and that, at all events, every important organ or muscle or nerve has been figured, described and named. Granting this, so far as the adult is concerned, although it is by no means true even for him, we have still to study the development of each of these organs or groups of organs, as seen at different ages, and, for some of them, in different races. As fast as these points are seen to be of practical interest, either in connection with diagnosis or the surgical treatment of disease, they are investigated ; but an ideal museum should furnish the investigator the means for his researches ; and it must, therefore, collect specimens without special regard to what is at present known to be their practical interest. The collection of such series of specimens of each joint, region and organ, as I have in mind, including sections and dissections at different ages from the earliest appearance in fœtal life to extreme old age in man, and in many cases in the lower animals, is a slow process. Such specimens, and especially such series of specimens, can only be prepared by a skilled anatomist, and there are few such ; hence, the formation of our ideal anatomical collection, limited though its scope may be, must be a work of time.*

There is ample material and scope for original work for half a dozen skilled anatomists for many years to come to supply the demands of this museum for illustrations of human morphology in its various relations, and it is not desirable to scatter effort over too wide a field.

The pathological section of a medical museum is its main feature, being, as Mr. Fowler remarks, the section to which, in the eyes of

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*As Sir William Turner remarks: "Where a question in human embryology hinges upon on examination of parts in a very early state of development, we have often to wait for many years before an appropriate specimen falls into the hands of a competent observer."

Hunter and his successors, all others form merely the introduction. It is true that to some physicians, specimens in this department seem to have little value; but they are balanced by those physicians whose chief interest in a case of disease is to get a post-mortem. No doubt much of the ancient pathology, and some of that which is quite recent, is comparable to the looking in the dark for a black spot which is not there, but those who despise pathology, and devote their entire attention to symptoms and treatment, err as much on one side as those who talk and act as if a knowledge of pathological anatomy could take the place of clinical experience do on the other. I do not know, however, that the doctrine usually preached, viz: that each man should attain the just mean in his views, is a true one. Certainly it is not the principle on which the universe seems to be constructed; the balance is maintained, not by having everything exactly symmetrical, but by excess in one direction balancing excess in another.

To secure pathological specimens in their most instructive forms for museum purposes requires, in many cases, not only considerable variation from the usual routine methods of post-mortem examinations, but very considerable delay in ascertaining the results. If, for example, we wish the best specimens of the results of cerebral disease, the brain must not be removed and sliced up in the usual manner; it should be hardened *in situ* to a certain extent, and its sections should be carefully considered with reference to their preservation in their relations to each other before they are actually made. There is need of a treatise by a skilled pathological anatomist giving such methods in detail from the modern point of view.

Thus far, the great majority of contributions of pathological material to our museum have been made by army medical officers; but some of the most valuable specimens have come from practitioners in civil life and it is to these last that we must appeal for illustrations of the effects of disease in all parts of the country. There are difficulties in the way, of course. The physician in private practice does not make post-mortem examinations in five per cent. of the deaths of patients under his charge, and when he does come into possession of an interesting specimen he is very naturally inclined either to keep it himself, especially if it is an osteological one which can be preserved with little expense or trouble, or to put it in the little collection which has been formed at the dispensary, or asylum, or hospital. I hope, however, that when it becomes known that we are trying to form in Washington a complete medical museum for the benefit of the whole medical profession, and that we have the means of permanently and securely preserving and exhibiting to the best advantage the specimens sent to us, I say that I hope and believe that when this is understood, many physicians will be willing to take a little trouble, and to give up something of their very natural impulse to keep a trophy of their skill, or a curiosity to talk about, in order to promote the general good.

As a rule, single specimens of abnormity or of disease have little scientific value ; it is only when they are associated with others that they both furnish and receive light. To this audience it is unnecessary to give other reasons as to why physicians should contribute material to the national collection, nor as to why the curator of this collection is justified in being very bold in requesting such material ; but there is one objection to parting with certain specimens which is sometimes made, and to which I will refer, because it brings up one of the ways in which our ideal medical museum can meet a practical need of the family practitioner. The objection I refer to is, that the specimen may be important from the point of view of medical jurisprudence ; that it has a special bearing in certain suits for malpractice, etc., and that, therefore, the owner wishes to keep it to be used as testimony to protect himself or his neighbors. There is some truth in this ; but it is also true that such specimens brought together in the national museum would be just as available as ever for the protection of the rights of the individual physician, while they would also be available for the benefit of the whole community.

Whether the specimens preserved are, or are not, desirable for and useful to the museum, it is certain that the securing and forwarding them is a very useful thing to the physician who does it. It tends to keep him in touch with current living thought and work of the profession, to direct his attention to the connection between symptoms and the mechanism of their production, which is often so important in deciding on the remedy to be used, and, above all, it gives him an interest in other men's work, and thus broadens his views and increases his knowledge and pleasure.

Having obtained the specimens, the next difficulty is so to prepare and preserve them that they shall be available for study. The great majority cannot be preserved in such a manner as to retain their natural color, size and texture. No doubt more might be done in this direction than is usually done. It is possible to stain or paint portions of specimens in such a way as to give some idea of the normal appearances, but thus far, I think, experience shows that the best medium for the permanent preservation of wet pathological specimens is alcohol, and this will contract and harden most tissues, and remove the color from nearly all. It is also an expensive mode of preservation for large collections, and requires constant care to prevent the effects of evaporation. It does not follow, however, that such specimens are of little value, and that, as some have urged, it would be better to seek to obtain records of the results of disease by colored drawings or models. The pathological specimen, whether seen at the post-mortem, or years afterward in a museum, is, to the scientific pathologist or to the practical physician, merely a sign or hieroglyph of the morbid process which has produced it ; it is a result, in most cases, of interest not in itself, but because of the preceding phenomena which it connotes. As Sir James Paget has said, the same objection, viz : that museum specimens are unfit for the teaching or the study of pathology, might be made to the study of botanical specimens in an herbarium. "In both cases alike, the changes produced by preparation are so far uniform that any one accustomed to recent specimens (and no others should study either herbaria or pathological collections) can allow for them or 'discount' them. Just as an anatomist can discern, in a recent specimen of disease, the healthy structure ; so, but often much more clearly, can the pathologist or any careful student discern in the prepared specimen the chief characteristics of the disease."* Colored drawings, casts and models are of great value in supplementing original specimens, but they cannot wholly replace them.

A good preparation, whether of normal or abnormal structure, but especially the latter, is valuable, not only for what we can see in it, but also for what we overlook or misinterpret, and which our successor may see, and see rightly. In this it is better than a mere description, yet the latter is equally necessary and much more easily preserved and made generally useful. Next to the preparation itself in accuracy and completeness of record is the photograph, and next to this is a good model, or a careful drawing.†

In medical and surgical matters, as in most other things, we habitually think in terms of vision as interpreted by touch. Hence, in part, the importance of the so-called object-teaching, and the fact that what the medical lecturer shows his class will usually be much better remembered and understood than what he says to it. And, while pictures and diagrams are of great assistance they are by no means as instructive and suggestive as representations in three dimensions, i. e., models, if the thing itself is not available.

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* British Medical Journal, 1880, ii.

† To realize the value of a good drawing, one should consult the illustrations of the works of Vesalius, Eustachius and other anatomists of the sixteenth and seventeenth centuries. The dissections and preparations which they made perished long ago. It is true, that there is still in existence, at Basle, a skeleton prepared by Vesalius; and possibly a few other osteological specimens preserved by the older anatomists and pathologists may still be in existence, but, as a rule, to which there is almost no exception, we must depend on the plates of these old folios to get at the true meaning of the text.

One of the most important sections of our museum is that devoted to microscopy, including normal and pathological histology and photomicrographic work. In the cabinets there are nearly 11,000 mounted specimens, illustrating almost every field of microscopical research. Many of these were made twenty years ago and more, and were mounted by processes which have not given good results, so that Dr. Gray, who is in charge of this section, estimates that about 3000 will be set aside as worthless ; but the rest form a very valuable series to which additions are being constantly made, and materials for which we are specially anxious to obtain. In connection with this section a series of cultures of chromogenic and pathogenic bacteria is kept up for museum exhibits, and also to illustrate methods of work.

While the great majority of the specimens in a medical museum have some relations to diagnosis, prognosis, or therapeutics, the number of those which are of direct interest to the so-called practical physician is not very great. It includes models and casts illustrating dermatology, morbid growths, the results of amputations, excisions, plastic operations, etc., and instruments, apparatus, dressings, etc., of all kinds. Here also may be classed hospital fittings and furniture, means of transportation for sick and wounded, model cases of instruments, emergency chest, etc. Our medical museum has a fair beginning of a collection of this kind, including over a thousand specimens ; but many more are needed to make it reasonably complete. If each medical man who devises a stethoscope, a pessary, a speculum, an ophthalmoscope, or an electro-therapeutic appliance with which he is well pleased, would send a specimen to the collection, its increase would certainly be rapid, and it could always show the latest improvement.

An ideal medical museum should be very complete in the department of preventive medicine, or hygiene. It is a wide field, covering, as it does, air, water, food, clothing, habitations, geology, meteorology, occupations, etc., in their relations to the production or prevention of disease, and thus far has had little place in medical museums, being taken up as a specialty in the half dozen museums of hygiene which now exist.

Our own National Museum of Hygiene, is, as you know, under the direction of the Medical Department of the Navy. It is a very interesting collection of sanitary appliances of various kinds ; but it is not well housed, is much overcrowded, and its location is so inconvenient that it receives but few visitors, and, therefore, has by no means the educational influence that it ought to have. It should be provided ample quarters in the immediate vicinity of the National and of the Army Medical Museums, to both of which it would form a very desirable supplement. In our medical museum, at present, military hygiene only is illustrated, and this only in a few branches, such as hospitals, means of transportation of wounded, etc. As regards materia medica, an exceedingly well arranged collection, including about 5,000 specimens, has been formed in the National Museum, under the direction of the Surgeon-General of the United States Navy, mainly by Dr. J. M. Flint of that service. The relations of materia medica to natural history, commerce, and the arts, which are subjects belonging especially to the National Museum, are as close as they are to medicine, and I am very glad that our national collection in this branch is where it is, and under its present management. In the Medical Museum we have a collection showing what is supplied in the way of drugs, instruments, etc., to the medical department of our army, and, as opportunity offers, we shall extend this to include the medical supplies of other armies or services.

The extent to, and manner in, which a medical museum should deal with anthropological and ethnological problems are not questions to be discussed in the abstract with advantage, since the answers must differ greatly according to circumstances. In our National Museums the matter has been so arranged that all material relating to anthropometry, or to real or supposed structural differences in man according to race, are cared for in the Medical Museum, while specimens illustrating manners and customs, implements, weapons, clothing, pottery, etc., are taken charge of in the anthropological division of the National collection.

The Army Medical Museum contains what may seem a large amount of material relating to human osteology, and especially craniology, in its relations to North American ethnology, or the history of the development of different varieties of man on this continent; but it is not actually half large enough to permit of drawing definite scientific conclusions from it. The majority of the crania which it contains have been measured to a certain extent, and the results have been published; but many other measurements are desirable to permit of comparison with series taken elsewhere, and even measurements already made must be repeated by later and better methods. We have been trying some experiments with composite photography and superimposed contour tracings as a means of obtaining typical outlines and dimensions for race groups of crania, and these give promise of good results. If the collections of crania of North American Indians in Boston, New York, Philadelphia and Washington could be brought together, a very much better average representation of the majority of tribes or groups would be obtained than can be furnished by either of these collections taken separately. By composite photography and tracings, combined with uniform methods of measurement, we can practically bring these collections together, and obtain results nearly as satisfactory as if we had them all in one room. We have also fitted up one large room with instruments and apparatus for anthropometry in its widest sense, including psychophysical investigation, and it is intended to make this a complete laboratory for illustration of methods of work.

In London arrangements have been made to have such an anthropometric laboratory in an outbuilding at the South Kensington Museum. The two things have no connection, and it seems to have been placed there because it would obtain more visitors desirous of being measured and tested than if placed anywhere else. In this laboratory, which is, I believe, essentially the same sort of institution as that arranged by Mr. Francis Galton at the Health Exhibition in 1884, and is planned by Mr. Galton, any person can have the regular series of measurements and tests made upon himself for a charge of six cents. There are difficulties in the way of making a charge for such measurements in a government establishment, and there are also difficulties in undertaking to do such work gratis, chiefly on account of the cost. It is, however, so desirable that it should be done, and the data from such observations systematically carried on for a series of years would be so valuable, not only from a scientific point of view, but for practical purposes in connection with life insurance interests and very possibly with practical medicine, that we should endeavor to overcome these difficulties in some way, and I think it can be done sufficiently, at least, to stimulate private enterprise in this direction. It is possible that we may yet see in large cities establishments of this kind, directed by skilled and reputable physicians having the confidence of the profession, where not only normal but abnormal conditions can be determined; places where the secretions can be tested chemically and microscopically, ophthalmoscopic and endoscopic examinations of all kinds made, the mode of functioning of muscles and nerves determined, and an authoritative record of the results made for the use of the individual, as evidence of his condition, or for the information of his physician. It would require an already established reputation and much skill and tact on the part of the director of such a laboratory, with absolute refusal to give prescriptions or advice in any shape, to make it fully successful; but it may be done.

An important feature of our national medical museum should be to show methods of research and of instruction for the benefit of the investigators and teachers of the country. This includes instruments and apparatus, and, to a limited extent, illustrations of the modes of using them and of the results ; it also includes diagrams, models, etc., used for illustrating lectures. For example, as soon as Koch's researches became known in this country, physicians, and especially medical teachers who visited the museum, asked if we could show them the apparatus used by Koch and Pasteur in bacteriological work, and eagerly examined the few specimens of cultures on solid media which we were able to exhibit. The anatomist comes to the museum quite as much to see methods of mounting and preservation, as to see the specimens themselves ; the physiologist does not expect to see function directly exhibited, but he does hope to find information about kymographs and constant temperature apparatus, and he wants to see whether Kühne's artificial eye is so useful for teaching purposes that he ought to get one to illustrate his lectures.

. Medical museums are not, as a rule, freely open to the public, nor are they collected or arranged with reference to interesting or instructing non-professional persons. The Medical Museum at Washington is the chief exception to this rule, and it is so, because it was placed in Ford's Theatre, the scene of the assassination of President Lincoln. Many visitors to Washington, both men and women, wished to see this memorable spot, and in doing so, necessarily went through the Museum. This gradually led to the adjusting of the specimens exhibited with a view to the fact that they were to be seen by a number of non-professional persons of both sexes. Certain groups of specimens were put aside and not shown except to persons known to be physicians, while other groups were given prominent places because they interested the public, although not of great professional or scientific value.

On the other hand, the public has gradually become accustomed to consider the Army Medical Museum as one of the "sights" of Washington, to be visited by male and female, old and young, and when a stranger comes to the city and inquires what he ought to see, this museum will probably be named to him next after the National Museum. Since the collection has been moved into the new building near that devoted to the National Museum, of which it may almost be said to form a part, the number of visitors has rather increased than diminished, and it has been found desirable to consider with care some problems which this state of things has forced on the attention of the curator. That educated men and women should have some curiosity as to the structure of their own bodies, the functions of certain organs, the arrangement of parts in certain localities where they have felt pain or discomfort, or the changes in which have caused death in relatives or friends, is perfectly natural and proper, and there is no objection to gratifying this curiosity to a very considerable extent. The wonder to me is, not that boys and girls, youths and maidens, men and women, like to see specimens which will teach them something on these points, but that so many of them remain ignorant of, and careless about, the wonderful mechanism of their own bodies. Now what are the specimens in a medical museum which most interest the public, and in what direction is it expedient to try to direct this interest and to do educational work by means of the exhibits? In the first place, the majority of men and women, when at leisure and trying to amuse themselves, or to pass away time, prefer things that appeal more or less to the emotions, rather than those which appeal only to the intellectual faculties. The skeleton of a hand will be barely glanced at; but if it were known that it had been the hand of a great general, a great writer or a great criminal, it would be a specimen that almost every one who visits the museum would wish to see. Usually it is not expedient, nor even possible, to furnish the personal data which would arouse this purely emotional interest.

When people come to the Army Medical Museum and ask where General Smith's brain, or Judge Brown's heart, or the Hon. Mr. Jones's larynx, or Guiteau's skeleton is, and are informed by the attendant that he does not know where it is, and is not even certain that it is in the collection, there are some expressions of disappointment, it is true; and sometimes the curator is appealed to as a last resource; but a few words of explanation as to what the main purpose of the museum is, and the suggestion that one would not like to have his or her father's skull displayed and labelled with his name, no matter how great or how infamous he may have been, is usually quite sufficient to satisfy the seeker.

This addition of interest to a specimen by calling attention to certain sentimental or historical associations connected with it, is not only proper but desirable, for all specimens not derived from the human body; but for these last, the rule should be to wait a hundred years before publicly labelling them with the names of the persons from whom they are derived.

For scientific and professional purposes we, of course, want a history of the specimen, which will, as far as possible, give the data connected with its peculiarities, and among these may be race, occupation, and even name, though the emotional element does not enter into it at all. If, for example we have before us a specimen of cancer of the stomach, it might be of great interest, taken in connection with the symptoms, or in regard to the question as to whether pylorectomy or gastro-duodenostomy would have been justifiable ; but from a scientific point of view it would add little to the value of the specimen to know that it was from the body of Napoleon and not from an unknown soldier.

To return to our question as to what interests the public. Of specimens illustrating the anatomy and physiology of man no doubt the most interesting to non-medical persons are those connected with reproduction. In the hall of the Army Medical Museum, which is open to the public, we do not place specimens illustrating specially the anatomy of the genital organs ; but we do exhibit a series illustrating embryology, and especially the development and growth of the human embryo, and there is no case in the museum before which the average visitor will linger longer. The specimens are clearly labelled ; a lady may go there alone, and, unnoticed, may at her leisure learn something about her own peculiar function, and the provisions for the life of the new organism ; and I think she will hardly find the same facilities for this self-study anywhere else in the world. I do not mean by this that other museums may not have larger and more instructive collections of such specimens, but that they are not available for the information of modest, respectable non-professional women.

In what has been said thus far, it is chiefly the utilitarian point of view that has been made use of ; but this is by no means the whole matter. No art, and no branch of science should form the sole end and object of a well balanced life, and there are objects in every large museum which are of great interest, though they appeal rather to the emotional than the intellectual faculties of the spectator. There are many specimens in the Army Medical Museum which I would rather see removed than to lose John Hunter's lancet, which has no scientific interest whatever. So also its collection of between three and four hundred medals and tokens relating to medical institutions or distinguished medical men, or commemorating outbreaks of pestilence or the victories of preventive medicine, is one which should be made complete and fully displayed, though it would not be easy to demonstrate its utility to any one unless he were interested in the history of the struggles and triumphs of the medical profession.

The objects of a medical museum are to preserve, to diffuse, and to increase knowledge. Its conservative function is to form a permanent record of what has been demonstrated and to fix the meaning of terms. Even in my brief experience of thirty years the terminology of anatomy, physiology, pathology, chemistry and of most of the specialities has greatly changed, and this not only by addition of new terms, but by the dropping of old ones. To get useful results from the older literature we must know the precise significance of the old words, and, in some cases, the best way to learn this is to examine the specimens prepared by those who used such terms in their descriptions. The specimens in our museum which came from the collections of Professor William Gibson and Dr. Frank Hastings Hamilton are especially valuable, because they were the basis of practical teachings, and should be examined by any one criticising these teachings.

A large proportion of the pathological specimens in this museum illustrate conditions which now rarely occur, forming a group which it is safe to predict will never be duplicated. It is not only that they were gathered during a great war, but that they illustrate the results obtained when antiseptic surgery, as now understood and practiced, was unknown. Never again, I hope, will there be brought together such a collection of the effects of pyogenic microörganisms on gunshot wounds, especially of bone, as may be seen in its cases.

The museum also preserves, for future investigations, objects whose nature or relations are not understood at the time when they are received, and which occur so rarely that the means of studying them by comparison can only be obtained through such preservation.

Upon the function of a museum as a diffuser of knowledge ;—as a means of education, it is needless to dwell. That it should also strive to increase knowledge is equally certain. This is to be effected by study and comparison of its materials. The results of such study and comparison of a part of the Army Medical Museum collection have appeared in the volumes of the *Medical and Surgical History of the War*. Another part will, I hope, soon be utilized in a study of its collection of human skeletons and crania which has been commenced by Dr. Matthews, of the Army. But a considerable part is as yet only in the stage of agglomeration, and our present business is to collect and preserve, leaving to the future its full utilization.

A medical museum is really used, for purposes of study, by very few persons ; but through the teaching of those few its lessons are made known to the whole profession. American physicians in investigating a subject do not, as a rule, think of inquiring as to what museums can show with regard to it, simply because they have not had convenient access to large collections and are not accustomed to make use of them. Thirty years ago we were in much the same situation in respect to medical literature ; but as the libraries have grown, desire for biographical research has grown also, and I think that in like manner when we have secured a comprehensive National Medical Museum it will not only be made use of, but will give a powerful stimulus to the formation and progress of other more special collections elsewhere.

What should be the relation of this central national collection to those formed in different parts of the country, either in connection with medical schools, or with museums of broader scope? Certainly they should help one another, and this can be done in many ways. I do not in the least object to a generous rivalry to do the best work, to have the most instructive and the most artistic preparations. That is a good thing. But I would say to the anatomist of a school, when you have made a preparation which is noteworthy, offer to make a copy for the national collection, where it will be seen by the anatomists of all schools and of all countries. To the pathologist of a medical school I would say, after you have secured type specimens for your own collection put aside other good specimens for the National Medical Museum, which will furnish you materials for the purpose.

On the other hand, the collections of the National Museum are available for study by any proper person, and its duplicates should be used to aid other museums which may be in special need of them.

In common with several of the largest and most important medical museums, more especially those of the Royal College of Surgeons and of the Faculty of Medicine of Paris, the Army Medical Museum has the advantage of being closely associated with a large medical library which is in the same building, and at present under the same direction. The increased utility and attractiveness which this gives to both library and museum is very decided.

It is true that in some other institutions similarly arranged there has been some grumbling as to the proportion of funds allowed to the museum and to the library respectively, the museum enthusiast claiming that the librarian would rather have one rare old pamphlet than half a dozen entirely new vertebrates, while the bibliophile is sure that the demand of the profession for access to a full supply of books and journals is much greater than that for access to specimens. I can only say, from my own experience, that one who has charge of a library only, will probably not hesitate to take museum funds, if he can get hold of them, to buy books; but that when one person is responsible for both he will endeavor to give each its fair share of the resources at his command.

If we had to choose between having a great national medical library and a great national medical museum, no doubt most of us would take the library, because it would be of more immediate use to us; but no such unpleasant alternative is forced on us. There is no reason why we should not have both, and we must have both.*

I have time for only a very condensed statement of the wants of our National Medical Museum. In the first place it needs the intelligent interest and friendship of the medical profession of this country. To a very considerable extent it has had this ; were it otherwise it would not be what it is, nor where it is. But it needs more of it, and it can never have too much. Every medical man in this country should help a little and provide for the perpetuation of his name as that of a physician interested in the progress of the profession by sending at least one specimen to it. It is omnivorous in its demands for material, as will be seen by the circular which it has recently issued. But I will name as special wants, human embryos, especially those of a very early age, monstrosities and malformations of all kinds in man or in the lower animals ; results of old injuries, such as fractures or dislocations, or of surgical operations, such as excisions, stumps, etc. ; injuries and diseases of the eye, ear and nose ; new growths of all kinds ; diseases of the brain and spinal cord ; and specimens illustrating the condition of bones, joints, brain, larynx and other organs in extreme old age.

In the second place it needs a regular supply of funds from the general government. To form and keep in proper condition such a medical museum as this should be is a more difficult and expensive matter than those not acquainted with such work would suppose, and the gifts of specimens from the profession must be supplemented by ample means for the preparation, preservation and proper display of these specimens, and also for the purchase of apparatus and typical specimens of foreign work, in order that the Museum may be always able to show the latest state of knowledge and the best way of doing things.

The annual appropriation for the Museum at present is $5,000. This is sufficient except that the printing of the catalogue, of which I shall speak presently, must be an extra charge ; but the medical profession should see to it that the amount is not reduced in the rhythmic spasms of partial economy with which some of our statesmen are afflicted.

The third need of the Museum is of a series of the right kind of descriptions of its specimens, given on labels and in a catalogue. Unaided by such descriptions it has for each man that which he can see in it, and no more. One man will see nothing but an old piece of bone, a shapeless mass of tissue bleached by alcohol, a case of old dingy brass instruments. Another will see in the same things a rare joint atrophy, implying curious abnormal nerve influence; a leprous nodule, whose history, if we knew it, would reach back through the lazar-houses of the middle ages to the far east, and whose bacilli may be the lineal descendants of those that vexed Naaman the Syrian; a case of microscopes illustrating the development of that instrument, from the first rough iron tube of the spectacle-maker of Nuremburg to the delicate and complicated instrument through which we now peer curiously into that world which lies within the world of unassisted vision. By our labels and catalogues we must tell men what to see; but to do this we must first see ourselves. The aphorism that a first-class musem would consist of a series of satisfactory labels with specimens attached means a good deal. Something has been done in this direction, as you will see on inspection of the cases; but I often wonder what sort of labels a man who has spent years in investigating the normal and abnormal structure and relations of one organ would write for our specimens of that organ. Such help as this we need; kindly, truthful criticism, the pointing out of errors and of new points of view for this mass of material.

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* "There are few things in relation to our science of which I am more sure than this, that every possible method of studying it should be by all possible means promoted." Sir James Paget, in Lancet, January 22, 1887, p. 159.

We also need a series of printed catalogues. One of these should be in the form of compact handbooks relating to particular sections of the collection, and intended partly for the use of visitors while in the museum and partly as a ready means of letting distant friends know what material it most needs in different departments. It should also print a complete illustrated catalogue of the whole collection for the use of the investigators and teachers of the profession. Congress has been requested to grant authority for the printing of such a catalogue by the Government Printer. The material for it is nearly ready, and it would make three volumes each the size of one of the volumes of *The Medical and Surgical History of the War of the Rebellion.**

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* Some large and valuable collections have no formal catalogues; but the results have been published in essays, monographs or text-books by those who have formed them. This is the rule as regards the collections at the various anatomical and pathological institutes and laboratories of continental schools. I have examined most of the published catalogues of medical museums, partly to obtain information as to the best methods of doing such work, and partly to ascertain what might be worth indexing in them. Some of them are mere lists of specimens, of no value except for use in the museum itself. A few give accounts of many specimens, especially in pathology, which make them valuable works of reference apart from the collections themselves. To what extent such detailed descriptions should be made for publication, including brief histories of cases, depends partly on the character of the specimens, partly on the skill of the describer and partly on whether illustrations are to be used or not.

The subject of museum organization and management is one of those with regard to which it has been said that a man who is interested in it passes through three successive states of mind, viz: First, he thinks he knows almost all about it, except a few minor points of detail which he is going to look up. Second, he feels that he will never know anything about it. Third, he believes he knows a little and hopes by experience and study to know more.

The museum needs earnest and well-trained students to work up its collections so as to advance knowledge, and, at the same time, to display properly the specimens so as to make them most instructive. To all such students we shall endeavor to afford opportunities for this work. Precisely how this is to be effected is not yet clear, but here is abundance to be done, and there are quite a number of men coming on the stage who want to do such work for its own sake, because it gives them pleasure. Sooner or later we shall have half a dozen or more of specially trained men busy in the laboratories and work-rooms of the museum, each engaged on his own problems, and the whole for the common good.

The medical museum hints at matters which lie outside the scope of known physical and chemical laws. Physicians have not, as a rule, been very virulent theologians; their studies and their daily work tend to give them compensation of bias in this particular, and, therefore, in this age of transition in beliefs, it is not so true of them as of others, that "the old hopes have grown weak, the old fears dim, the old faiths numb." In our medical museum yonder may be found abundant illustrations of the results of physical and chemical actions and reactions upon what was once living matter, and was connected with centres of consciousness, of intellect, of emotions which imply something more than ordinary protoplasm, or mere metabolism. It brings together strange company. The men who dwelt on the sides of the Andes in the old Aztec days, the men who built cities in the Gila Valley centuries before the days of Columbus, the Esquimaux, and the Indian of the plains, black and white, red and yellow, all sorts and conditions of men are represented in those bony caskets which once held their centres of life and thought; but now are reckoned only as so many crania in the Museum catalogue. The great majority of the pathological specimens imply either suffering or death, or both, of the individual from whence they came. Some of them are the results of intemperance, of lust, of folly and crime; but some are the results of unselfish sacrifice for the good of others, true flowers of blood and pain. A large group of them form one of the relics of an acute paroxysm of disease of a great nation. The old pensioner likes to keep the battered ball which crippled him, and so these relics have an interest beyond that which is purely professional. That the nation is not crippled by its loss, takes nothing from their interest, and the fact that we are physicians does not imply that we look upon them from a medical or scientific stand only. Those of the combatants who survive are now better friends than ever, and the museum specimens, coming as they do from the sick and wounded of both armies, and contributed by both Union and Confederate surgeons, enforce the lesson of the unity of the profession and of its interests, as well as that of our country.

Our museum, like the library with which it is associated, includes all the specialties. No physician is so learned or skillful that he can find no instruction there, and no one is so ignorant that he cannot comprehend some of the lessons which it teaches. Taken together these institutions should contribute in no small degree to our national prestige, for which eminence in scientific work and teaching is an essential element, and if it be remembered that they are only twenty-five years old, and that during that period we have been making medical history at a tremendous rate, surely some incompleteness and crudeness may well be excused or overlooked.

Speaking in behalf of the army medical department, and for the dead as well as for the living who have been charged with this work, I can truly say that we have been very proud of our charge, and that we have done our best, each according to his capacity and opportunities, to make the museum and library such as a great profession and a great nation have a right to demand.

APPENDIX.

Tables showing for some of the principal Medical Museums of the world, the number of specimens, the number of recent additions of specimens and the expenditure for the last five years.

Locality and Name of Museum.	Total Number of specimens.	Number of specimens in each Department.					Number of specimens added during last five years.	Amount expended during last five years.
		Comparative Anatomy.	Normal Human Anatomy.	Embryology.	Pathological Anatomy.	Materia Medica.		
UNITED STATES.								$
ALBANY:								
Albany Medical College Museum[1]	5500	250	1250	200	3100	700	770	660
BOSTON:								
Warren Anatomical Museum, Harvard University[2]	7900	----	----	----	----	----	470	8,973
CHARLESTON, S. C.:								
Museum of Medical College of State of South Carolina[3]	800	----	----	----	800	----	----	----
CHICAGO:								
Chicago Medical College Museum[4]	1332	122	300	10	200	700	----	----
Rush Medical College Museum	850	70	100	50	100	200	----	----
CINCINNATI:								
Museum of Miami Medical College and Mussey Collection[5]	3078	450	603	75	823	1002	----	----
Museum of Hospital and Pathological Department of Cincinnati University	1250	----	----	----	1250	----	----	889
LOUISVILLE:								
Museum of Medical Department of University of Louisville[6]	1992	276	275	127	868	446	----	2,250
NEW ORLEANS:								
Museum of Medical Department of Tulane University of Louisiana[7]	2500	----	----	----	----	----	----	500
Museum of New Orleans Charity Hospital	238	6	20	12	200	----	----	----

[1] Information kindly furnished by Dr. Joseph D. Craig, Curator.

[2] " " Prof. W. F. Whitney.

[3] " " Dr. R. A. Kinloch.

[4] " " Dr. Elbert Wing.

[5] " " Dr. N. P. Dandridge.

[6] " " Dr. J. M. Bodine.

[7] " " Dr. Rudolph Matas.

Locality and Name of Museum.	Total number of specimens.	Number of specimens in each Department.					Number of specimens added during last five years.	Amount expended during last five years.
		Comparative Anatomy.	Normal Human Anatomy.	Embryology.	Pathological Anatomy.	Materia Medica.		
NEW YORK:								$
Pathological Cabinet of the New York Hospital[8]	2366	----	----	----	2366	----	542	14,028
Medical and Surgical Museum, Medical Department of University of New York	8000	1000	4000	500	2500	----	50	7,250
Museum of College of Physicians and Surgeons[9]	2209	43	214	93	880	800	196	2,750
Museum of the Carnegie Laboratory[10]	1200	----	----	----	----	----	----	----
Wood Museum, Bellevue Hospital	2224	256	282	69	1613	----	----	----
PHILADELPHIA:								
Mütter Museum, College of Physicians of Philadelphia[11]	3700	296	242	140	3000	----	248	----
Wistar and Horner Museum, University of Pennsylvania[12]	7458	919	1355	292	2717	2175	----	2,950
Museum of Jefferson Medical College[13]	2500	----	----	----	----	----	1000	----
ST. LOUIS:								
St. Louis Medical College Museum	900	100	125	75	600	----	----	----
WASHINGTON, D. C.:								
Army Medical Museum	14360	1685	2853	108	8354	814	3789	23,356

[8] Information kindly furnished by Dr. F. Ferguson.

[9] " " Dr. T. M. Prudden.

[10] " " Dr. F. S. Dennis.

[11] " " Dr. Guy V. Hinsdale.

[12] " " Dr. D. D. Richardson.

[13] " " Dr. Morris Longstreth,

[14] " " Prof. G. Homan.

Locality and Name of Museum.	Total Number of specimens.	Number of specimens in each Department.					Number of specimens added during last five years.	Amount expended during last five years.
		Comparative Anatomy.	Normal Human Anatomy.	Embryology.	Pathological Anatomy.	Materia Medica.		
GREAT BRITAIN.								$
BIRMINGHAM:								
Museum of Queens College[1]	3270	277	652	107	1400	834	1250	----
CAMBRIDGE:								
University Museum[2]	----	120000	4000		----	----	----	50,000
DUBLIN:								
Trinity College, Museum of Normal Human Anatomy	562	----	442	120	----	----	362	2,175
Trinity College, Museum of Anatomy and Zoology[3]	14125	13580		----	----	----	1000	4,000
Trinity College, Pathological Museum[4]	4815	----	----	----	4815	----	650	----
Trinity College, Museum, of Materia Medica[5]	200	----	----	----	----	----	----	----
Museum of Royal College of Surgeons[6]	9797	3576		71	5011	1139	----	10,280
EDINBURGH:								
Anatomical Museum of University of Edinburgh[7]	10000	6000			4000	----	310	5,975
Museum of Royal College of Surgeons of Edinburgh[8]	6700	1000	1050	350	4000	----	----	----
LEEDS:								
Pathological Museum Yorkshire College Medical Department[9]	3000	----	100	----	2000	500	220	----

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[1] Information kindly furnished by Dr. Bertram C. A. Windle, Curator.

[2] Data received through kindness of Dr. G. E. Paget.

[3] Data furnished by Prof. M. H. N. Mackintosh.

[4] Professor E. H. Benet, the curator, has kindly furnished the data.

[5] From data furnished by Professor Walter S. Smith.

[6] Information kindly furnished by the Curator, Dr. Alexander B. McKee and Prof. Rawdon Macnamara.

[7] For these data the author is indebted to the kindness of Professor Wm. Turner, Conservator of the Museum.

[8] From data kindly furnished by the Conservator, Dr. Charles W. Cathcart, F.R.C.S.

[9] Data kindly furnished by Dr. Thomas Pridgin Teale, F.R.C.S.

Locality and Name of Museum.	Total Number of specimens.	Number of specimens in each Department.					Number of specimens added during last five years.	Amount expended during last five years.
		Comparative Anatomy.	Normal Human Anatomy.	Embryology.	Pathological Anatomy.	Materia Medica.		
LIVERPOOL:								$
Anatomical and Pathological Museum, University College[10]	2347	87	97	93	1500	570	600	3,655
LONDON:								
Museum of Medical School of St. Bartholomew's Hospital[11]	7000	250	1200	150	5500	1400	939	6,740
Museum of Guy's Hospital[12]	11500	1929	1504	62	7515	500	358	10,066
Museum of Kings College[13]	6500	3000	323	177	2508	874	299	----
Museum of College of Surgeons	28015	4278	3426	----	5650	----	1068	61,210
Museum of St. George's Hospital[14]	6010	345	457	134	4644	430	356	3,800
St. Thomas Hospital Museum[15]	5940	673	656	----	4017	594	520	4,560
Pathological Museum of Charing Cross Hospital[16]	1265	----	----	----	1265	----	----	----
Museum of Medical Department of University College[17]	7500	391	765	270	5000	1000	641	8,750
MANCHESTER:								
Medical Museum of Owens College	6694	1763	281	135	2515	2000	----	----
NORFOLK:								
Norfolk and Norwich Hospital Museum	2537	156	100	30	2351	----	71	400
OXFORD:								
University Museum[18]	8500		6922		----	----	580	8,145

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[10] From information kindly furnished by Reginald Harrison, Esq., F.R.C.S.

[11] Data kindly furnished by Dr. Norman Moore, F.R.C.S.

[12] From data kindly furnished by the Curator, Dr. G. N. Pitt, M.R.C.S.

[13] " " " Prof. J. W. Groves.

[14] " " " T. Holmes, Esq., F.R.C.S.

[15] " " " Dr. Wm. M. Ord.

[16] " " " John H. Morgan, Esq., F.R.C.S.

[17] " " " the Curator, C. Stonham, Esq., F.R.C.S.

[18] " " " John Burdon Sanderson, Esq., M.D.. F.R.S.

Locality and Name of Museum.	Total Number of specimens.	Number of specimens in each Department.					Number of specimens added during last five years.	Amount expended during last five years.
		Comparative Anatomy.	Normal Human Anatomy.	Embryology.	Pathological Anatomy.	Materia Medica.		
FRANCE.								$
NANCY:								
Collection de la Faculté de Médecine[18′]	2980	344	886	95	905	750	----	3,166
PARIS:[19]								
Dupuytren Museum	6700	----	----	----	6700	----	300	5,000
Orfila Museum	14027	----	----	----	----	----	500	3,900
GERMANY.								
BERLIN:								
Museum des Path. Inst. Fried. Wilh. Universistät[20]	17600	----	----	----	17600	----	1526	----
Anatomische Sammlung[21]	3000	1000	1500	500	----	----	374	3,750
Pharmakologische Sammlung[22]	2000	----	----	----	----	2000	600	750
BONN:								
Sammlung für Pathologische Anatomie der Universität[23]	4000	----	----	----	4000	----	----	----
Sammlung für Pharmakologie	1100	----	----	----	1100	----	----	----
JENA:								
Anatomisches und Vergleichend-Anatomisches Museum der Universität[24]	4512	2490	2022	----	----	----	----	----
GÖTTINGEN:								
Pathologische Sammlung[25]	4192	----	----	----	4192	----	600	----

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[18′] Information kindly furnished by Dr. Baraban, Curator.

[19] For the information regarding the Dupuytren and Orfila Museums I am indebted to the kindness of Professor Dr. Leon Le Fort.

[20] Information kindly furnished by Prof. Dr. R. v. Virchow.

[21] " " Prof. Dr. W. Waldeyer.

[22] " " Prof. Dr. O. Liebreich.

[23] " " Prof. Dr. C. Binz.

[24] " " Prof. Dr. O. Hertwig.

[25] Information furnished by Prof. J. Rosenbach.

Locality and Name of Museum.	Total Number of specimens.	Number of specimens in each Department.					Number of specimens added during last five years.	Amount expended during last five years.
		Comparative Anatomy.	Normal Human Anatomy.	Embryology.	Pathological Anatomy.	Materia Medica.		
KIEL:								$
Anatomisches Institut der Universität[26]	2390	----	1520	870	----	----	350	5,775
Zoologisches Institut der Universität	15000	3000	----	----	----	----	----	9,158
LEIPZIG:								
Anatomische Anstalt der Universität[27]	3200	3200		----	----	----	----	----
Pharmakologische Anstalt	2500	----	----	----	----	2500	----	----
MÜNCHEN:[28]								
Anatomische Anstalt	3792	----	3722	70	----	----	400	----
Pathologisches Institut	5100	----	----	100	5000	----	1000	2,500
Obstetrische und gynæcologische Sammlung der Königl. Frauen Klinik	594	----	70	76	448	----	----	625
STRASSBURG:								
Pharmakologisches Institut der Universität[29]	1720	----	----	----	----	----	485	6,650
Anatomisches Museum der Univ.	2500	800	1580	120	----	----	609	1,875
Pathologisches Institut	8000	----	----	----	8000	----	625	6,250
AUSTRO-HUNGARY.								
BUDAPEST:[30]								
Erstes Anatomisches Museum der Universität[31]	1326	----	----	----	----	----	483	300
Physiologisches Institut der Universität[32]	1150	----	----	----	----	----	----	375
Pathologisch-Anatomisches Institut[33]	2560	----	----	----	----	----	275	1,000

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[26] Through the kindness of Professor F. von Esmarch the information regarding the collection at Kiel was received from Professors W. Flemming and K. Brandt.

[27] Data received through the kindness of Professor Wilhelm His.

[28] Information furnished by Dr. F. Winckel.

[29] For the information regarding the Museum of the University of Strassburg I am indebted to the kindness of Professor O. Schmiedeberg.

[30] The information regarding the Budapest Museum was obtained through the kindness of Professor J. v. Fodor.

[31] Information kindly furnished by Dr. Joseph von Lenhossek, Professor of Anatomy.

[32] Information kindly furnished by Professor A. E. Yendrassik.

Information kindly furnished by Dr. Gustav Scheuthauer.

Locality and Name of Museum.	Total Number of specimens.	Number of specimens in each Department.					Number of specimens added during last five years.	Amount expended during last five years.
		Comparative Anatomy.	Normal Human Anatomy.	Embryology.	Pathological Anatomy.	Materia Medica.		
WIEN: [34]								$
Museum der Anatomischen Anstalt	3582	77	3212	293	----	---	333	----
ITALY.[35]								
BOLOGNA:								
Museo d'anatomia patologia umana[36]	2472	----	----	----	2472	----	154	1,250
Museo di anatomia comparata[37]	6334	6334	----	----	----	----	175	2,500
Museo di anatomia veterinaria della Universita	1042	1034	8	----	----	----	551	8,450
Museo di patologia comparata[38]	3473	----	----	----	3473	----	76	800
Il museo d'anatomia umana normale fondata 1723[39]	4414	----	4414	----	----	----	248	605
PAVIA:								
Gabinetto di anatomia umana della Universita[40]	2678	----	2493	185	----	----	300	2,900
Museo di anatomia e fisiologia comparata[41]	5094	4580	----	370	----	----	----	4,300
Instituto di Fisiologia[42]	385	----	----	210	----	----	----	----
Gabinetto di anatomia patologica[43]	2300	----	----	----	2300	----	450	----
Instituto di patologia generale ed istologia[44]	2500	----	----	150	2350	----	500	2,200
Museo Porta di anatomia et patalogia chirurgica[45]	1848	----	----	----	1848	----	----	1,340
Museo dell istituto ostetrico ginecologico[46]	372	----	----	----	372	----	----	2,970
Gabinetto dermo-sifilopatico[47]	258	----	----	----	258	----	200	250
Manicomio Provinciale di Pavia in Voghera[48]	543	----	----	----	----	----	250	----
Gabinetto di materia medica[49]	1000	----	----	----	----	1000	250	1,780

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[34] Data kindly furnished by Professor C. Toldt.

[35] The data regarding the Italian Museums were kindly solicited for me by Professor A. Mosso.

[36] Information furnished by the Curator, Prof. Cesare Taruffi.

[37] " " " " Giuseppe Ciaccio.

[38] " " " " Cesare Taruffi.

[39] " " " " Luigi Calori.

[40] " " " " Giovanni Zoja.

[41] " " " " Leopoldo Maggi.

[42] " " " " E. Oehl.

[43] " " " " G. Sangalli.

[44] " " " " C. Golgi.

[45] " " " " Dr. B. Ciceri.

[46] " " Professor C. Alessandro.

[47] " " Dr. Angelo Scarenzio.

[48] " " Prof. Antigono Raggi.

[49] " " Prof. Alfonso Corradi, Director.

Locality and Name of Museum.	Total Number of specimens.	Number of specimens in each Department.					Number of specimens added during last five years.	Amount expended during last five years.
		Comparative Anatomy.	Normal Human Anatomy.	Embryology.	Pathological Anatomy.	Materia Medica.		
TORINO:								$
Inst. di anatomia normale dell Univ.[50]	12000	....	12000	----	----	----	3000	7,000
Museo di zoologia ed anatomia comparata[51]	2500	2500	----	----	----	----	----	----
Collezione di antropologia criminale[52]	2000	----	2000	----	---	----	----	----
Museo di materia medica	700	----	----	----	----	700	100	2,000
Museo di anatomia patalogia[53]	800	----	----	----	800	----	480	3,000
Museo Riberi ospedale St. Giovanni	887	----	----	----	887	----	389	2,040
BELGIUM.								
LIÈGE:								
Museum of the Anatomical Institute[54]	1183	----	----	----	1183	----	541	4,800
HOLLAND.								
AMSTERDAM:								
Anatomisch Museum en Museum Vrolik[55]	6200	900	1200	600	1500	----	577	2,500
DENMARK.								
COPENHAGEN:								
Pathologisch-anatomisches Museum[56]	6500	----	----	600	6000	----	523	2,160

[50] Information furnished by Prof. C. Giacomini, Director.

[51] " " Prof. Dr. A. Mosso.

[52] " " Prof. Ces. Lombroso.

[53] " " Prof. Pio Foà.

[54] " " Dr. A. Swaen.

[55] " " Prof. M. Furbringer.

[56] " " Dr. C. G. Lange.

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